CARLTON Oregon
INC 1899
A GREAT LITTLE TOWN

2014 WATER SYSTEM MASTER PLAN

November 2014

Westech Engineering, Inc.
3841 Fairview Industrial Drive SE, Suite 100
Salem, OR 97302

Work under this contract was funded in its entirety with federal grant funds from the Oregon Community Development Block Grant program.

PUBLIC HEALTH DIVISION
Center for Health Protection, Drinking Water Services
John A. Kitzhaber, MD, Governor

WESTECH
NOV 19 2014
RECEIVED

Oregon Health Authority

800 NE Oregon St.
Portland, Oregon 97232-2162
Voice (971) 673-0405
FAX or TTY (971) 673-0694

November 18, 2014

Raymond Engel, P.E.
Westech Engineers and Planners
3841 Fairview Industrial Drive SE, Suite 100
Salem, OR 97301-1192

Re: City of Carlton Water System Master Plan – October 2014
(PWS #00171; PR #187-2014)
Concurrence of Findings

The Oregon Drinking Water Services (DWS) received the "City or Carlton Water System Master Plan – October 2014" and associated plan review fee on October 27, 2014. Upon review, it appears the criteria listed in OAR 333-061-0060(5) have been met.

The City of Carlton Master Plan represents a 20-year planning year period extending from 2013 through 2033. The plan includes a description and evaluation of the water system, future demand estimates, hydraulic modeling, and a Capital Improvement Plan (CIP). The CIP includes a prioritized list of projects, and 2013 cost estimates.

Note that OAR 333-061-0060 contains plan submission and review requirements for all major water system additions or modifications to public water systems. All of the projects presented in the Master Plan would be subject to plan review requirements. Construction plans must be submitted to and approved by DWS before construction begins.

If you have questions, please contact me at 971.673.0406, or via email at fred.n.kalish@state.or.us.

Sincerely,

Fred Kalish, P.E.
Regional Engineer
Drinking Water Services

Cc: Bryan Burnham, City of Carlton, 191 E Main Street, Carlton, OR 97111
Gary Van Der Veen, Yamhill County
Peter Blumanthal, Westech Engineers and Planners

2014 WATER SYSTEM MASTER PLAN

CARLTON, OREGON

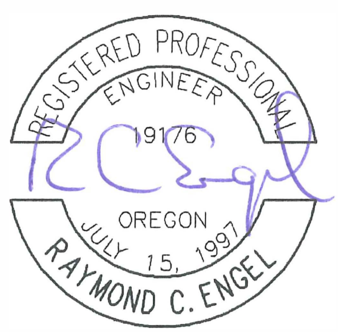
November 2014

Prepared for

City of Carlton, Oregon

191 E. Main Street

Carlton, OR 97111



RENEWS: 12/31/2015

Prepared By

Westech Engineering, Inc.

3841 Fairview Industrial Drive SE, Suite 100

Salem, OR 97302

(503) 585-2474

2674.4000.0

TABLE OF CONTENTS

Chapter **Page**

Chapter **Page**

Chapter **Page**

Chapter **Page**

Chapter **Page**

Chapter **Page**

Chapter **Page**

Chapter **Page**

LIST OF TABLES

LIST OF TABLES (CONTINUED)

LIST OF FIGURES

LIST OF APPENDICES

FOREWORD

USING THIS REPORT

This report will be used by many people whose needs for information will differ widely. Accordingly, an Executive Summary appears at the beginning of this report. The summary provides an overview of the report and presents the main conclusions. Readers may gain a good general understanding of the report and its contents by reading the summary. Additional detailed information is presented in the body of the report.

LIST OF ABBREVIATIONS

ADD	average day demand
ASR	aquifer storage & recovery
AWWA	American Water Works Association
ATS	automatic transfer switch
cfs	cubic feet per second
CIP	capital improvement plan
COBU	claim of beneficial use
CT	CT value refers to chlorine Concentration x contact Time
DBP	disinfection by-product
DOC	Oregon State Department of Corrections
EDU	equivalent dwelling unit
EPA	US Environmental Protection Agency
FEMA	Federal Emergency Management Agency
fps	feet per second
gpd	gallons per day
gpm	gallon per minute
GWR	Ground Water Rule
GWUDI	Ground Water Under the Direct Influence (of surface water)
HAA5	five haloacetic acids regulated by the EPA.
HP	horsepower
IGA	intergovernmental agreement
LCR	Lead and Copper Rule
MDD	maximum day demand
MMD	maximum month demand
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MG	million gallons
MGD	million gallons per day
OAR	Oregon Administrative Rule
ODOT	Oregon Department of Transportation
ODWS	Oregon Drinking Water Services (formerly Oregon Dept. of Human Services, Drinking Water Program)
OHA	Oregon Health Authority (formerly Oregon Department of Human Services)
OPSC	Oregon Plumbing Specialty Code
ORS	Oregon Revised Statutes
OWRD	Oregon Water Resources Department
PHD	peak hour demand
PLC	programmable logic controller
PRV	pressure reducing valve
psi	pounds per square inch
PWDS	Public Works Design Standards
RFP	request for proposals
SCADA	Supervisory Control and Data Acquisition (telemetry) system
SDC	system development charge
SMCL	secondary maximum contaminant level
UGB	urban growth boundary
USGS	United States Geological Survey
VFD	Variable Frequency Drive
WMCP	water management & conservation plan
WTP	water treatment plant

EXECUTIVE SUMMARY

Summary Outline

EXECUTIVE SUMMARY

INTRODUCTION

The purpose of this study is to provide a comprehensive evaluation of the City's water system with respect to its existing and future needs, identify improvements and associated costs necessary to meet those needs, and provide the City with a framework for the provision of water service through the year 2033.

This executive summary has been prepared to provide a concise overview of the evaluations and recommendations from each chapter of the study. A summary of the capital improvement program costs appears at the end of this section (as well as in Chapter 12).

PROJECT OBJECTIVES

This master plan has been developed to provide the City with a guide for short term and long term water system improvements and has been prepared as a reference document to assist the City as it evaluates the impacts of proposed development and land use on the water system.

This master plan accomplishes the following specific objectives:

- Establishes water system design and planning criteria
- Provides an inventory of the existing water system infrastructure
- Identifies current and future water system deficiencies on a prioritized basis
- Provides specific recommendations to the community and City Council for action
- Provides the City with a water system master plan that addresses the needs of both the City and regulating agencies

BASIS FOR MASTER PLANNING

The City's previous water master plan was completed in 1996. The previous water master plan outlined recommended improvements to the water system components including the distribution, storage, and transmission systems. A number of the major improvements recommended in the previous water master plan have been addressed. Also, some of the key assumptions used in the prior water master plan have not accurately reflected observed conditions. Given these considerations, and the fact that the life and planning horizon for a water master planning document is 20 years, with updates typically recommended on 10 year intervals, a new master plan was needed to address water system issues.

Study Area and Planning Considerations

The City's Comprehensive Plan was most recently published in 2000 with updates in 2007 and 2009. The Comprehensive Plan covers the City Limits and Urban Growth Boundary, which for Carlton is the same. The total area within the City Limits/UGB is 571.4 acres (as measured from CAD maps). Of the 571.4 acres, 199.2 acres are zoned as Agricultural Holding (AH) which is land that is currently undeveloped but available to support future growth.

The study period for this investigation is from year 2013 to 2033 and uses the City Limits/UGB as the boundary for municipal development across this period. The City currently provides water service to a population of approximately 2,065 within the City Limits/UGB plus over 100 connections outside the City. It is anticipated that municipal growth across the planning period will increase substantially, resulting in a 2033 population of just over 2,800, while connections outside the City are assumed to remain the same.

The improvements recommended in this plan are based on the development of land within the UGB in its present location, and the current zoning designations for these areas. This report evaluates the anticipated water supply, treatment and storage needs for the 20 year planning period. Implementation of the improvements will provide an adequate and dependable water system for the City's existing and future customers. Significant expansions of the UGB, or changes to the existing zoning areas could change the recommendations of this plan. An update or reevaluation of key planning assumptions should be performed should such changes occur.

Regulatory Requirements

The US Environmental Protection Agency (EPA) and the Oregon Health Authority (OHA), Oregon Drinking Water Services (ODWS) currently enforce drinking water standards for 91 primary contaminants and 15 secondary contaminants. Primary standards regulate contaminants that pose a serious risk to public health, whereas secondary standards cover aesthetic considerations. Public water systems must sample for primary contaminants routinely to ensure that standards are met and must report the results of such sampling to the regulating agency.

The City's water system operates in compliance with the current regulatory requirements. Regulatory compliance is achieved as a function of the basic water system design, the operational modes selected by the City's licensed operators, as well as the current regulatory structure. Anticipated future regulatory changes are not expected to have a significant impact on the City's water system infrastructure or operations.

Since Carlton uses a surface water source for supply (Panther Creek/Carlton Reservoir), the water system is subject to the extensive regulations governing surface water sources. Applicable regulations include those related to microbial contaminants, disinfection byproducts, corrosion control, arsenic, and inorganic, organic and radiological contaminants.

EXISTING WATER SYSTEM INVENTORY

The City operates and maintains the existing water system and delivers water to its consumer base utilizing Panther Creek/Carlton Reservoir as a source, a water treatment plant with a 0.30 MG clearwell, one 0.38 MG concrete and one 1 MG steel finished water storage reservoirs, and a network of distribution pipes. Under normal operating conditions fire protection is provided by the 1 MG steel finished water storage reservoir.

Based on City records, Carlton's original water system was constructed in about 1911. The initial infrastructure appears to have included a 30 foot long, 3 foot high concrete dam across Panther Creek just downstream of the current reservoir dam and a 9 mile long pipeline into town. The 0.38 MG concrete storage reservoir is believed to have been constructed in the early 1900s. Early records for water treatment are not available, but a system was in place prior to 1984 when the predecessor to the current water treatment plant was built. In 2003 the water treatment plant was expanded and upgraded and the 1 MG steel reservoir was constructed.

The City's water supply piping consists of three main elements: (1) the Treatment Plant Finished Water Line, (2) the Meadow Lake Transmission Main, and (3) the distribution mains in town. The Treatment Plant Finished Water Line is just over 7 miles long and contains 10-inch and 12-inch steel pipe. The Meadow Lake Transmission Main is about 1.8 miles long and is primarily 10-inch Cast Iron, with just over 1,400 feet of 16-inch ductile iron pipe at the 1 MG steel reservoir and crossing the North Yamhill River bridge. The distribution system contains nearly12 miles of pipe, over half of which is 6-inches or smaller, while the remainder is 8-12 inches in size. About 1/3 of the existing pipe is cast iron, 1/4 is PVC, and 1/4 ductile iron, with much of the remaining of an unknown type.

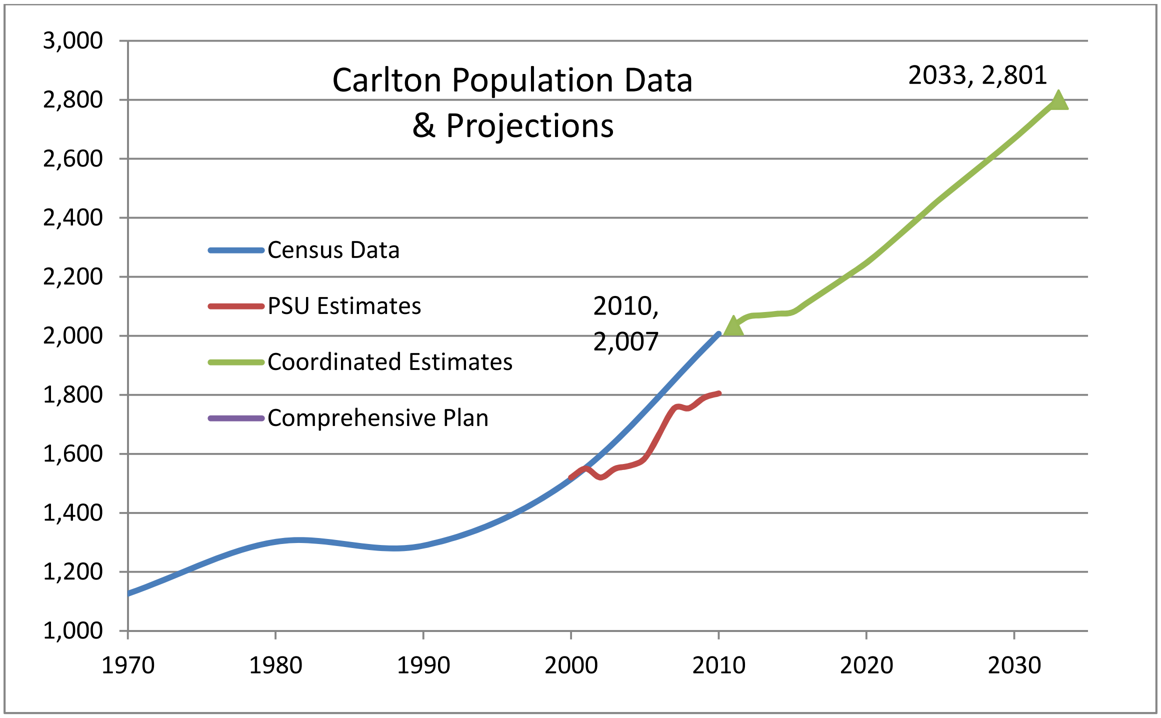
The City currently has a supervisory control and data acquisition (SCADA) system (located at the WTP) that allows for centralized monitoring and control of the system by the system operators from a centralized location (for those system components connected to the SCADA system). The 1 MG steel reservoir is the only location other than the water treatment plant connected to the SCADA system, receiving control valve signals and sending flow meter data.

PRESENT AND FUTURE WATER DEMANDS

At the most fundamental level, future water demands are a product of per capita water use patterns applied over the anticipated population growth. The per capita use factors utilized in this report are based on typical historical use rates and do not consider the effects of future conservation programs. The development of a conservation program is encouraged and will provide additional operating margins with regard to supply and capacity.

Historical populations were reviewed and future populations were projected based on conventional municipal growth patterns and the County coordinated population allocation. This report assumes a 2033 population of 2,801. This is based on the coordinated population estimates provided by Yamhill County. **Figure ES5-1** on the following page depicts the historical and projected populations based on this analysis.

Figure ES5-1 Municipal Population Projections



Water demand is defined as the sum of all water produced and delivered to the City distribution system. It includes water consumed in all use categories and also includes water loss and unaccounted-for water. Water demand varies across seasonal periods, days of the week, and hours of the day. The establishment of an average day demand (ADD) rate serves as the baseline against which other more intensified demands are measured. For this report the ADD was determined to be 160 gallons per capita per day (gpcd).

Because a significant amount of use occurs outside the City Limits/UGB different peaking factors were developed for inside and outside the City, and use outside the City assumed to not be subject to a growing population. In addition, because of the substantial portion of demand lost to leaks, total demand was divided into consumption and leak categories so that future demand would not assume leakage increasing with population.

The net result is that Average Day Demand of 160 gpcd is divided into 72 gpcd (45% of current values representing in-town consumption) which is adjusted for population growth and 24 gpcd (15% of current values for outside the city consumption) which is held steady over time when calculating future demands. As mentioned, losses are assumed to remain steady and are not subject changes with population or demand conditions.

The peaking factors calculated in the report are summarized in **Table ES5A**.

Table ES5A Peaking Factor Summary

Population Group	ADD) (gpcd)	ADD:MMD) Peaking Factor	ADD:MDD Peaking Factor	ADD:PHD (1) Peaking Factor
Inside City Limits/UGB	72	1.77	2.06	5.00
Outside City Limits/UGB	24	1.45	1.89	5.00

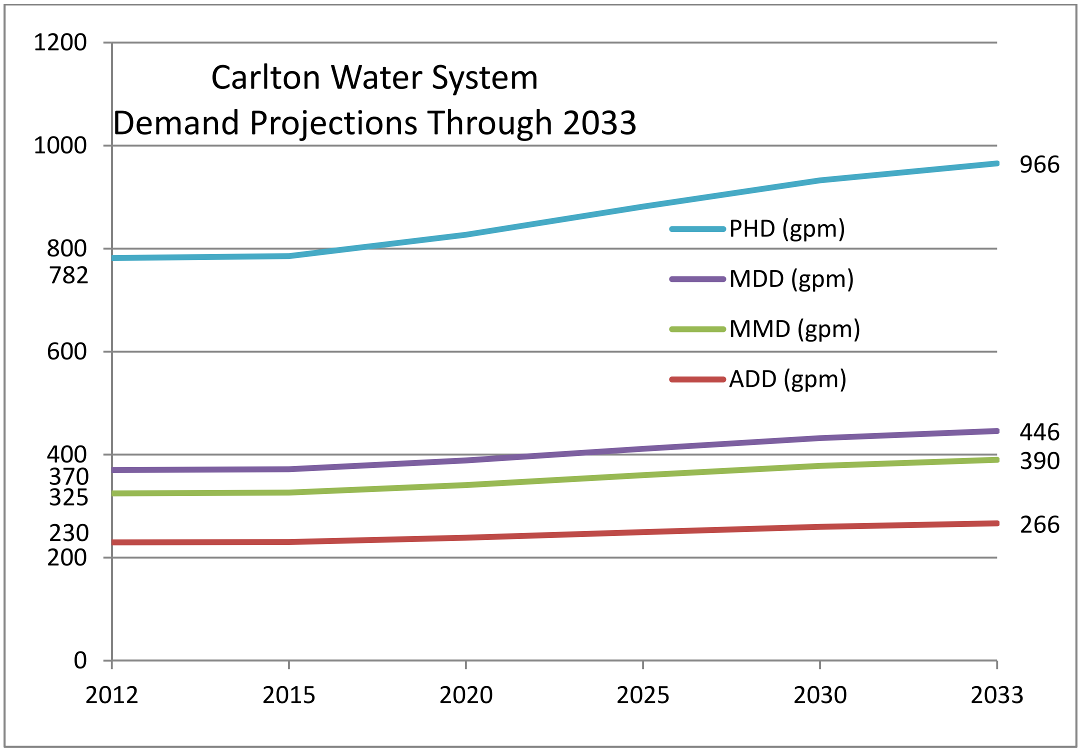
(1) Assumed peaking factor based on typical small system values.

Future water demand for the municipal population is calculated by adding the current demand to the product of the per-capita demand values times the projected additional population for the planning year in question. These results are summarized in **Table ES5-18** and illustrated in **Figure ES5-5** below.

Table 5-18 Summary of Projected Water Demands

Year	2012	2015	2020	2025	2030	2033
Population	2065	2080	2247	2465	2669	2801
Avg. Day Demand (ADD)						
MGD	0.331	0.332	0.344	0.359	0.374	0.384
(gpm)	230	230	239	250	260	266
Max. Month Demand (MMD)						
MGD	0.468	0.470	0.491	0.519	0.545	0.561
(gpm)	325	326	341	360	378	390
Max. Day Demand (MDD)						
MGD	0.533	0.535	0.560	0.592	0.622	0.642
(gpm)	370	372	389	411	432	446
Peak Hour Demand (PHD)						
(gpm)	782	785	827	882	933	966

Figure 5-5 Projected Average Day Demand and Maximum Day Demand



In addition to the demand scenarios already presented the study evaluated fire flow demands which range from 1,000 gpm in low density residential areas to 3,500 gpm in commercial and industrial areas and schools. Fire flow demands do not have a significant impact on the daily production and supply of water, but are critical when evaluating the transmission and distribution network.

WATER SUPPLY EVALUATION

The first element in providing a community with the water it needs is a source (or sources of supply). Two separate issues must be addressed in order for a source to be used and relied upon.

- The legal right to appropriate the water for the community's use.
- Water reliably available in sufficient quantity and quality combined with the infrastructure necessary to get that water to the water treatment plant.

Under Oregon water law, with few exceptions, the use of public water (both ground and surface water) requires a Water Right Permit from the Oregon Water Resources Department (OWRD). A Water Right Permit provides the legal right to appropriate the water subject to the conditions of the permit. Water Rights Permits are issued with expiration dates. To make the water right permanent a Claim of Beneficial Use (COBU) must be submitted to and approved by the OWRD. Upon approval of the COBU a Water Right Certificate is issued confirming the status of the right making it permanent. Typically the Water Right Certificate is limited to the amount demonstrated on the COBU. **Tables ES4-1a, ES4-1b and ES4-2** list the current water rights held by the City of Carlton.

Table ES4–1a Water Rights Summary/Certificated Rights/Water Use (listed by priority date)

Source Name(1)	Permit Rate CFS (gpm)	Volume(1) (AF)	Appl #	Perm #	Certificate #	Priority Date
Panther Creek	0.50 (224)	N/A	S-1609	S-914	1868	8-12-1911
Panther Creek & Carlton Reservoir	0.271(2) (121)	66	S-46505	S-34661	86064	10-22-1969
Panther Creek & Carlton Reservoir	0.018(2) (8)	9	S-69513	S-50218	86065	11-30-1987

(1) Water storage must be authorized in two parts. One part is the authority to store. The second part is the authority to use what was stored. This refers to the use of water that has been stored.
(2) These applications have been divided. This portion has been certificated. The corresponding items in Table 4-2 have been permitted but not certificated.

Table ES4–1b Water Rights Summary/Certificated Rights/Water Storage (listed by priority date)

Source Name(1)	Volume(1) (AF)	Appl #	Perm #	Certificate #	Priority Date
Panther Creek for Carlton Reservoir	66	R-46504	R-5527	85744	10-22-1969
Panther Creek for Carlton Reservoir	9	S-69512	R-10900	85747	11-30-1987

(1) Water storage must be authorized in two parts. One part is the authority to store. The second part is the authority to use what was stored. This refers to the authority to store the water.

Table ES4–2 Water Rights Summary/Water Use/Permitted Only, No Certificate (listed by priority date)

Source Name(1)	Permit Rate CFS (gpm)	Volume(1) (AF)	Appl #	Perm #	Certificate #	Priority Date
Panther Creek	2.50(2) (1,122)	N/A	S-44208	S-32489	N/A	10-27-1967
Fall Creek	2.00(3) (898)	N/A	S-44207	S-32488	N/A	10-27-1967
Panther Creek & Carlton Reservoir	0.229(4) (122)	N/A	S-46505	S-34661	N/A	10-22-1969
Panther Creek & Carlton Reservoir	0.052(4) (23)	N/A	S-69513	S-50218	N/A	11-30-1987
Willamette River	2.98(5) (1,338)	N/A	S-87762	S-54792	N/A	11-02-2011

(1) Water storage must be authorized in two parts. One part is the authority to store. The second part is the authority to use what was stored. This refers to the use of water that has been stored.
(2) An extension application for this was proposed for approval by OWRD but subsequently protested.
(3) An extension application has been submitted and is under review by OWRD.
(4) These applications have been divided. This portion has only been permitted, but not certificated. The corresponding items in Table 4-1a have been certificated.
(5) This water right totals 44.18 CFS for the Yamhill Regional Water Authority, of which 2.98 is intended for Carlton

From these tables we note that the City has certificated water rights totaling 0.789 cfs (354 gpm) and 75 acre-feet, and permitted water rights totaling 7.76 cfs (3,483 gpm). Overall the City is in comparatively good shape at this time with regards to water rights, but it has important work to do to strengthen its position by working towards certificating various currently permitted water rights.

With regard to the availability and reliability of Carlton's water supply there are a couple of key concerns identified. These include the reliability of the Panther Creek/Carlton Reservoir water source and working towards a stronger position with respect to source redundancy.

The Panther Creek/Carlton Reservoir source serves the City well, but it is subject to at least two challenges that can reduce its reliability. One is the high sediment and silt loads that can occur in conjunction with major winter storms. The other is the occurrence of higher temperatures and algae blooms that are believed to be exacerbated by the significant silt accumulation in Carlton Reservoir. The algae blooms create biomass in the water which tend to foul the filters and reduce the time the filter can operate before a backwash is required.

Furthermore, the silt accumulation is believed to be extensive enough that the storage volume of the reservoir is likely reduced. The original storage volume is estimated to have been around 60 acre-feet. With a surface area of approximately 4 acres, an average depth of silt of only 3 feet would reduce the total volume by 12 acre feet, or approximately 20% of the reservoir volume.

The following table is a summary of the various water source improvement recommendations developed by this master plan. For more details on particular projects, refer to the discussions in the body of the study.

Table ES6–3: Recommended Water Supply Improvements & Projects

Project Code	Project
S-1	Panther Creek Reservoir Contingency Reserve
S-2	Carlton Reservoir Dredging/Silt Removal
S-3	Intertie Connection, WTP with McMinnville Water & Light
S-4	Carlton Reservoir Inlet Box Repairs
S-5	Upon approval of an extension of time, partially perfect 2.19 cfs of Permit S-32489
S-6	Update extensions of time for Permit S-34661 and Permit S-32488.
S-7	Develop and submit an extension of time for Permit S-50218.
S-8	Install a system that regularly measures streamflow in Panther Creek upstream of Panther Creek Reservoir.
S-9	Water Management & Conservation Plan update when required by OWRD.

Water Treatment Evaluation

The City operates a direct filtration water treatment plant located about 3/4 of a mile downstream of Carlton Reservoir. As already noted, because Carlton's water source is surface water a significant number of regulatory requirements govern the necessary treatment before the water is passed on to consumers. Because of the range of concerns there is no one-step process that is capable of meeting all of the requirements. Therefore treatment consists of a series, or train of steps each designed to address specific concerns.

One of the primary treatment concerns is the removal of microbial contaminants. Specifically targeted are viruses, Giardia lamblia, and Cryptosporidium. As living organisms these tend to occur in greater numbers in water with high turbidity, which contains the nutrients and conditions they need to grow. As such a key element of controlling microbial contaminants is reducing turbidity levels. At the Carlton WTP this occurs in a two step process where the influent water has chemicals injected to cause the smaller particles to flocculate/coagulate into larger particles that are then removed by the WTP filters. The filtration of the particles removes both the host environment as well as a significant number of the microbial contaminants.

The other method of controlling microbial contaminants is inactivation which is done by chlorine disinfection. Once the influent passes through the filters is receives a dose of chlorine. The chlorine requires time to work, so the water moves from the filters to the clearwell which is simply a large tank provided to give the chlorinated water a delay before it moves on to the distribution piping.

Other treatment concerns include disinfection byproducts, taste and odor concerns, and lead and copper. Disinfection byproducts (DBPs) result from the reaction between certain elements in the water and the chlorine used for disinfection. DBPs are considered harmful and are controlled by limiting the levels of chlorine allowed for disinfection. Iron and Manganese are the primary causes of taste and odor concerns and these are removed by precipitation from the water by chlorine injection prior to the filters. Lead and copper concerns arise from the existence of these metals in private plumbing systems which dissolve at greater rates in lower pH water. Thus, pH adjustment is provided by the injection of sodium hydroxide downstream of the filters.

Overall the existing water treatment plant is performing well and has the capacity to provide the necessary treatment for projected demands throughout the study period. As presented above the estimated maximum day demand in 2033 is 0.642 MGD (446 gpm). The plant capacity has three main limiting factors, the filters, the chlorine contact time, and the downstream distribution system. The plant has four filters with a combined capacity of 975 gpm. The flow rate for chlorine contact time is currently limited to 473 gpm based on a tracer study conducted in 2012. The downstream piping is estimated to have an unrestricted flow rate on the order of 700 gpm.

Based on those numbers the key limitation is currently the 473 gpm associated with chlorine contact time. An evaluation of the size of the chlorine contact chamber determined that under appropriate conditions the flow rate for contact time could be increased to well above the 700 gpm capacity of the downstream piping and the 975 gpm limit of the filters and still meet regulatory requirements. At this time the 473 gpm provides sufficient capacity so that higher rates are not essential. If for operational purposes the City wished to increase the plant capacity above the 473 gpm limitation it could request a new tracer study from the ODWS which would be provided at no cost to the City.

The following table is a summary of the various water treatment recommendations developed by this master plan. For more details on particular projects, refer to the body of the study.

Table ES7-1 Recommended Water Treatment Improvements & Projects

Project Code	Project
WT-1	Periodic Coating Inspection of the Clearwell
WT-2	Repaint the Clearwell
WT-3	Request New Tracer Studies to Increase Allowable WTP Flow Rates

Distribution System Evaluation

The primary purpose of a water distribution system is to deliver the full range of consumer demands and fire flows at pressures suited for the particular use. To accomplish this, the distribution system utilizes a combination of large transmission mains and networks of smaller distribution mains.

The existing transmission and distribution system was evaluated and existing or anticipated deficiencies were identified. In general, distribution system deficiencies fall into several general categories, although some elements of the water system may be experiencing more than one of these problems at the same time. These include the general categories of (1) lack of capacity, (2) lack of facility, and (3) end of useful life.

The primary concern for Carlton's water distribution system is the lack of fire flow capacity. Lack of fire flow capacity is attributable to undersized pipes in the Meadow Lake Transmission Main and in the distribution main grid within the City Limits/UGB. Construction of an 18-inch line for the Meadow Lake Transmission Main from the 1 MG steel reservoir to Yamhill and Main (leaving the existing 16-inch across the bridge) would substantially increase the fire flows in the vicinity of Yamhill and Main, but it would not substantially increase fire flows in the northern, eastern or southern parts of town. However, until the Meadow Lake Transmission Main is completed, constructing larger waterlines within the City Limits/UGB would have minimal effect on fire flows anywhere.

Improvements to the transmission and distribution system will be required to meet projected demands or to address system reliability issues. The following table is a summary of the various water transmission & distribution recommendations developed by this master plan. For more details on particular projects, refer to the discussions in the body of the study.

Table ES8–3 Recommended Transmission/Distribution Improvements & Projects

Project Code	Location	Extg φ (inch)	New φ (inch)	Length (feet)
	Treatment Plant Finished Water Line			
F-1	Finished Water Supply Line Contingency Reserve			
F-2	WTP Finished Water Line (WTP to Concrete Reservoir)	8 Stl	12	34,500
	Transmission System(*generally listed west to east*)			
T-1	Concrete Reservoir Valve Improvements			
T-2	Meadow Lake Road Transmission Main Segments B-E (Meadow Lake Road at Steel Reservoir to North Yamhill, Excluding the Bridge)	8/10 CI	18	8,130
T-3	Meadow Lake Road Transmission Main Segment A (Meadow Lake Road from the Concrete Reservoir to the Steel Reservoir)	10 CI	18	1,575

Project Code	Location	Extg φ (inch)	New φ (inch)	Length (feet)
	Distribution System (*generally listed north to south, west to east*)			
D-1	North Kutch Street (Monroe to Madison)	6 CI	12	300
D-2	West Monroe Street (Yamhill to Kutch)	-	12	240
D-3	Monroe Street (Kutch to Pine)	6 CI	12	300
D-4	North Yamhill Street (Main to Monroe)	6 / 6 CI	12	450
D-5	North Pine Street (Main to Monroe)	-	12	450
D-6	West Main Street (Yamhill to Kutch)	8 CI	10	240
D-7	South Yamhill Street (Main to Grant)	-	12	300
D-8	West Grant Street (Yamhill to Pine)	4 CI / 2 PVC	12	650
D-9	South 3rd Street (Main to Polk)	6 CI	10	1,350
D-10	Railroad ROW (Johnson to Roosevelt)	-	12	1,000
D-11	West Johnson Street (Kutch to Railroad ROW)	6 CI	12	250
D-12	North Kutch Street (Madison to Johnson)	6 CI	12	700
D-13	East Monroe Street (1st to 4th)	6 CI / 4	10	820
D-14	North 3rd Street (Main to Monroe)	2 PVC	10	450
D-15	Monroe Street (Pine to 1st)	6 CI	12	440
D-16	North Yamhill Street (Roosevelt to McKinley)	4 STL	10, 12	200
D-17	West McKinley Street (Yamhill to Scott)	-	10	600
D-18	West Johnson Street (Kutch to Howe)	6 Stl	8, 10, 12	670
D-19	West Jefferson Street (Yamhill to Kutch)	-	12	240
D-20	West Madison Street (Yamhill to Kutch)	-	10	250
D-21	South Cunningham Street (Main to Grant)	1 C	8	200
D-22	West Grant Street (Cunningham to River)	-	8	500
D-23	South Carr Street (Main to Grant)	4 CI	8	280
D-24	South Scott Street (Main to Grant)	-	10	290
D-25	South Park Street (Grant to Polk)	2 GALV	10	1,000
D-26	Polk Street (Park to Southeast of the Elementary School)	4 CI / 4 PVC	10	1,450
D-27	East Harrison Street (2nd to Linke)	4 CI	8	1,000
D-28	South Linke Avenue and Elementary School Loop (Harrison to Polk)	4 CI	8	900
D-29	South Park Street (Polk to Adams)	4 C	10	740
D-30	West Adams Street (Park to Pine)	-	8	200

D-31	West Grant Street (Carr to Yamhill)	4 CI	8, 10	830
D-32	North Yamhill Street (Johnson to McKinley)	4 STL / CI	8, 10	800
D-33	North Howe Street (Johnson to Lincoln)	2	8	450
D-34	North Gilwood Street (Monroe to 4-inch Loop Line)	4 CI	8	500
D-35	East Jefferson Street (1st to 4th)	6/3 STL	8	800
D-36	North 3rd Street (Monroe to Jefferson)	4 CI	8	600
D-37	West Monroe Street (Scott to Yamhill)	6 CI	10	620
D-38	East Monroe Street (4th to 6th)	4	8	450
D-39	North 1st Street (Main to Monroe)	2 GALV	8	450
D-40	North 2nd Street (Main to Monroe)		8	450
D-41	North 5th Street (Main to Monroe)	2 PVC	8	450
D-42	Main Street Connections (5th and 6th Street Intersections)	-	8	120
D-43	South Kutch Street (Grant to Taft)	2 / 4 CI	8	777
D-44	West Taft Street (Kutch to Park)	2 GALV	8	200
D-45	East Taft Street (2nd to 3rd)	6 PVC / 6 AC	8	250
D-46	North Scott Street (North of Monroe)		10	600
D-47	North Scott Street (Monroe to Main)		12	400
D-48	South 1st Street (Main to Washington)		8	600
D-49	East Taylor Street (East of Arthur)		10	400
D-50	South Park Street (South of Taylor)	4 CI	8	400
D-51	East Main Street (7th to Modaffari)	6 CI	8/10	1300
D-52	South 3rd Street (South of Polk Street)		10	950
	Interim Isolation Valve Improvements		Quantity	
V-1	Added 4-inch Interim Isolation Valves, Various Locations		8	
V-2	Added 6-inch Interim Isolation Valves, Various Locations		11	
V-3	Added 8-inch Interim Isolation Valves, Various Locations		2	
	East Carlton Water Company Water Meter and Double Check			
M-1	Install New Master Meter and Double Check			

WATER STORAGE EVALUATION

In most municipal distribution systems, the water system service pressure is determined by the elevation of the free water surface in the storage reservoirs serving the system. This is the case for Carlton's water distribution system.

The primary functions of water storage are to provide a reserve of water to equalize daily variations between supply and consumer demand, to serve fire-fighting needs, and to meet system demands during an emergency interruption of supply. The overall storage within a system can be divided into the several storage categories, including operational storage, equalization storage, standby (emergency) storage, fire suppression storage and dead storage.

As discussed in detail in the body of the report, the total volume of a reservoir often does not equal the effective volume available to the water system. The effective storage volume is defined as the reservoir volume below the bottom of the operational storage level, minus any dead storage. There is no dead storage in either of Carlton's finished water storage reservoirs.

The total recommended storage in the system is the sum of equalization, fire and emergency storage (while discounting any dead storage and operational storage). Discounting the operational storage and dead storage as noted above, the effective volume of the existing Carlton reservoirs is as listed in **Table ES9-2** below.

Table ES9–2 Effective Storage Volume, Existing Reservoirs

Existing Reservoir	Total Storage (MG)	Operational Storage [(1)] (MG)	Effective Storage (MG)	% of Total Storage Available
1 MG Steel Reservoir	0.956	0.061	0.895	94%
0. 38 MG Concrete Reservoir	0.38	0.063	0.317	83%
Totals	1.336	0.124	1.212	91%
(1) Assumes normal operating range of reservoirs consists of the upper 2 foot of each reservoir.				

Table ES9-3 compares the required storage with the available storage as shown in **Table ES9-2** above. It is important to remember that the only demands relevant to the calculation of the required storage are those downstream of the storage. Thus, for Carlton consumption and leaks between the water treatment plant and the storage reservoirs are not relevant to the storage calculations.

Table ES9–3 Finished Water Storage Evaluation (MG)

Year	2012	2015	2020	2025	2030	2033
Equalization (30% MDD)	0.102	0.123	0.130	0.140	0.149	0.155
Emergency (2x ADD)	0.445	0.448	0.472	0.503	0.532	0.551
Fire flow (3 hr @ 3,500 gpm)	0.630	0.630	0.630	0.630	0.630	0.630
Total	1.177	1.201	1.232	1.273	1.311	1.336
Available Effective Storage	1.212	1.212	1.212	1.212	1.212	1.212
Storage Deficit	**-**	**-**	**-0.02**	**-0.061**	**-0.099**	**-0.124**

Based on these numbers the existing finished water storage reservoirs fully meet the recommended storage volumes until 2020, and by the end of the planning period the deficit is only 124,000 gallons or 10% of the recommended total volumes. It should be noted that the recommended volumes are quite conservative, thus a deficit of 10% is not a significant concern. As such the report recommends that the City anticipate planning for additional storage capacity later in the planning period, but that no immediate action is necessary with regard to designing or constructing a new finished water storage facility.

While new storage infrastructure is not viewed as necessary, there are maintenance items recommended for the existing storage reservoirs. The 1 MG steel reservoir is likely to need painting inside and out within the next 5-10 years and the wood structure covering the 0.38 MG concrete reservoir needs maintenance and repair in the near future. The recommendations also note that reducing leaks will effectively add storage capacity and thus extend the timeframe before additional storage capacity is needed. These recommendations are summarized in **Table ES9-9.**

Table ES9–9: Recommended Water Storage Improvements & Projects

Project Code	Project
R-1	Periodic Internal Coating Inspection of the Steel Reservoir
R-2	Recoating existing 1 MG Steel Reservoir
R-3	Wood Siding Maintenance or Replacement at the 0.38 MG Concrete Reservoir
R-4	Address the questions concerning the Concrete Reservoir Boundary and Access Easement
R-5	Replace steel transmission & distribution mains to decrease volume required for equalization storage and standby storage (see recommended improvements in Chapter 8)

Instrumentation and Control Evaluation

Daily, and sometimes hourly, observations of water system operating parameters are required to ensure that the system is performing within regulatory standards and meeting operational goals. Immediate notification of critical alarm conditions is paramount to ensuring a continuous supply of water to the public and is often necessary to protect the City's infrastructure.

In mid 2010, the City issued an RFP to select a SCADA/Telemetry/Control System consultant to evaluate the City's existing instrumentation, control and SCADA system, and provide the City with recommendations for needed system improvements. Through this competitive process, the City selected Portland Engineering, Inc. (PEI) as the City's SCADA/Telemetry/Control System consultant of record. PEI will be working with the City directly to develop specific recommendations for the control system upgrades.

Therefore, the recommendations in this report are limited to general suggestions on locations where telemetry improvements are anticipated. A detailed evaluation is beyond the scope of this master plan. Also, the City anticipates adding the sewer pump stations and wastewater treatment plant to the SCADA system at some point in the future, so any upgrades to the existing system should be expandable to accommodate this approach.

Recommended Capital Improvement Plan

As summarized in the previous sections, the water system has a number of deficiencies, which inhibit the City's ability to provide an adequate level of water service throughout the physical system throughout the years of the planning period. Some of these deficiencies are more critical than others. Some deficiencies present an immediate effect on the ability to provide adequate service, while other deficiencies will manifest as the City expands and the existing system continues to age.

A prioritizing process was developed to rank the improvement projects since the scope of the proposed improvements is large. Factors utilized in the prioritizing process included several measures of criticality (such as public health concerns, end of useful life, inadequate capacity, and City priority), as well as the cost and benefit of each project.

Priority 1A and 1B are targeted to problem areas needing immediate attention. They have been developed to resolve existing or near term system deficiencies, resolve regulatory compliance issues or to serve known near term developments. To aid in the development of a water system capital improvement program (CIP), each improvement project was examined and assigned to one of the priority classes described above.

Table ES12-1 below summarizes the priority category totals presented in **Table ES12-2**.

Table ES12-1 Cost Summary, Capital Improvement Recommendations

Priority Group	Total Estimated Project Cost
Priority 1A	$ 4,092,000
Priority 1B	$ 8,854,000
Priority 2	$ 4,512,000
Priority 3	$933,000
TOTAL	$18,391,000

Table ES12-2 is a comprehensive listing of the recommended water system improvement projects. The general location of many of the prioritized improvements is shown on **Figure 12-1** and **Figure 12-2** (in the body of the report). It should be noted that the project listing within a priority class is also ranked in general order of recommended priority (although Public Works and the City Council will set the final project prioritization). The reader is referred to the body of this report for more detailed descriptions of the individual projects.

To the extent feasible, it is recommended that the City implement as many of the Priority 1A improvements under a single funding package if possible, and under as few funding packages as possible otherwise. Work on the Priority 1A and 1B improvements should begin as soon as feasible after agency approval and City adoption of this master plan. It is anticipated that Priority 2 projects will be required within the planning period; however, these projects can begin as finances become available and as the need arises.

The City does not currently have the resources nor is the City's existing user fee structure sufficient to fund all of the recommended improvements; therefore, alternative funding sources must be pursued. Several potential funding sources are identified and discussed in the last portion of Chapter 12 of the master plan. All funding options will likely require an increase of the user rate and SDCs.

CITY OF CARLTON WATER MASTER PLAN

TABLE 12-2 CIP PRIORITIZATION MATRIX

Project	Project Description	Estimated Project Cost	Capital Cost	Consequence of Failure	Probability of Failure	Regulatory Compliance	Improves Fire Flow	Improves Water Quality	Improves Operability	Economic Development	TOTAL POINTS	Priority Group
		Weighing Factor (1-3)	1	3	3	2	2	1	1	1		
Priority 1A Improvements			**Matrix Scoring**: Based on a scale of 1 to 4 with 1 being the 'least favorable' and 4 the 'most favorable'									
F-1	Finished Water Supply Line Contingency Reserve (WTP to Concrete Reservoir)	$ 50,000 [1]	3	4	4	1	1	1	1	1	**34**	1A
S-1	Panther Creek Reservoir Contingency Reserve	$ 50,000 [2]	3	4	2	2	1	3	3	1	**34**	1A
S-3	WTP Intertie with McMinville Water & Light	$ 150,000	3	4	2	1	1	1	3	1	**30**	1A
T-1	Concrete Reservoir – Valve Improvements	$ 35,000 [3]	4	3	2	3	1	1	4	1	**33**	1A
T-2	Meadow Lake Transmission Main, Segments B–E (From Steel Reservoir to Yamhill Street)	$ 2,017,000	1	4	2	1	3	1	1	3	**32**	1A
D-1	North Kutch Street (Monroe to Madison)	$ 55,000	1	2	1	1	4	2	1	3	**26**	1A
D-2	West Monroe Street (Yamhill to Kutch)	$ 42,000	1	2	1	1	4	2	1	4	**27**	1A
D-3	West Monroe Street (Kutch to Pine)	$ 60,000	1	2	1	1	4	2	1	4	**27**	1A
D-4	North Yamhill Street (Main to Monroe)	$ 92,000	1	2	1	1	4	2	1	4	**27**	1A
D-5	North Pine Street (Main to Monroe)	$ 90,000	1	2	1	1	4	2	1	4	**27**	1A
D-6	West Main Street (Yamhill to Kutch)	$ 87,000	1	2	1	1	4	2	1	4	**27**	1A
D-7	South Yamhill Street (Main to Grant)	$ 57,000	2	2	1	1	4	2	1	3	**27**	1A
D-8	West Grant Street (Yamhill to Pine)	$ 134,000	1	2	1	1	4	2	1	3	**26**	1A
D-9	South 3rd Street (Main to Polk)	$ 271,000	1	2	1	1	4	2	2	2	**26**	1A
D-10	Railroad ROW (Johnson to Roosevelt)	$ 228,000	1	2	1	1	3	2	1	3	**24**	1A
D-11	West Johnson Street (Kutch to Railroad ROW)	$ 63,000	2	2	1	1	3	2	1	2	**24**	1A
D-12	North Kutch Street (Madison to Johnson)	$ 173,000	1	2	1	1	3	2	1	2	**23**	1A
D-13	East Monroe Street (1st to 4th)	$ 167,000	1	2	1	1	3	2	1	2	**23**	1A
D-14	North 3rd Street (Main to Monroe)	$ 86,000	1	2	1	1	3	2	1	2	**23**	1A
D-15	West Monroe Street (Pine to 1st)	$ 100,000	1	2	1	1	3	2	1	2	**23**	1A
V-1	New 4-inch Isolation Valves (Various Locations)	$ 44,000	4	1	1	1	1	2	4	1	**21**	1A
V-2	New 6-inch Isolation Valves (Various Locations)	$ 67,000	4	1	1	1	1	2	4	1	**21**	1A
V-3	New 8-inch Isolation Valves (Various Locations)	$ 14,000	4	1	1	1	1	2	4	1	**21**	1A
M-1	East Carlton Water Company Water Meter and Double Check Valve	$ 60,000	2	1	1	2	2	1	3	1	**21**	1A

Priority 1A Estimated Cost Total

$ 4,092,000

Project Code Legend:

D = Distribution F = Finished Water Line R = Reservoir/Storage S = Water Source/Supply T = Transmission V = Valve Replacement WT = Water Treatment

Footnotes:

1. Project F-1 is an **annual** contingency reserve budget for anticipated near-term repair projects related to the finished water supply line. The total cost of waterline replacement appears as project F-2 under the Priority 1B Improvements.
2. Project S-1 is a contingency reserve budget for a near-term feasibilty study or pilot dredging project. Total cost of the reservoir dredging and rehabilitation appears under the Priority 2 Improvements.
3. Project T-1. The final scope of this project is still being evaluated.

CITY OF CARLTON WATER MASTER PLAN
TABLE 12-2 CIP PRIORITIZATION MATRIX

Project	Project Description	Estimated Project Cost	Capital Cost	Consequence of Failure	Probability of Failure	Regulatory Compliance	Improves Fire Flow	Improves Water Quality	Improves Operability	Economic Development	TOTAL POINTS	Priority Group
		Weighing Factor (1-3)	1	3	3	2	2	1	1	1		
Priority 1B Improvements			**Matrix Scoring**: Based on a scale of 1 to 4 with 1 being the 'least favorable' and 4 the 'most favorable'									
R-1	Internal Coating Inspection of Steel Reservoir	$ 15,000 [1]	4	2	1	1	1	1	1	1	**20**	1B
R-2	Concrete Reservoir Siding, Roofing and Electrical	$ 150,000	2	2	1	2	1	1	1	1	**20**	1B
WT-1	Internal Coating Inspection of Clearwell	$ 15,000 [2]	4	2	1	1	1	1	1	1	**20**	1B
T-3	Meadow Lake Transmission Main, Segment A (From Concrete Reservoir to the Steel Reservoir)	$ 368,000	1	4	4	1	1	1	1	1	**32**	1B
F-2	WTP Finished Waterline (WTP to Concrete Reservoir)	$ 6,765,000 [3]	1	4	4	1	1	1	1	1	**32**	1B
D-16	North Yamhill Street (Roosevelt to McKinley)	$ 47,000	3	1	1	1	3	1	1	1	**20**	1B
D-17	West McKinley Street (Yamhill to Scott)	$ 110,000	2	1	1	1	3	1	1	1	**19**	1B
D-18	West Johnson Street (Kutch to Howe)	$ 149,000	2	1	1	1	3	1	1	1	**19**	1B
D-19	West Jefferson Street (Yamhill to Kutch)	$ 51,000	2	1	1	1	3	1	1	1	**19**	1B
D-20	West Madison Street (Yamhill to Kutch)	$ 53,000	2	1	1	1	3	1	1	1	**19**	1B
D-21	South Cunningham Street (Main to Grant)	$ 37,000	2	1	1	1	3	1	1	1	**19**	1B
D-22	West Grant Street (Cunningham to River)	$ 73,000	2	1	1	1	3	1	1	1	**19**	1B
D-23	South Carr Street (Main to Grant)	$ 47,000	2	1	1	1	3	1	1	1	**19**	1B
D-24	South Scott Street (Main to Grant)	$ 60,000	2	1	1	1	3	1	1	1	**19**	1B
D-25	South Park Street (Grant to Polk)	$ 188,000	1	1	1	1	3	1	1	1	**18**	1B
D-26	Polk Street (Park to SE of the Elementary School)	$ 289,000	1	1	1	1	3	1	1	1	**18**	1B
D-27	East Harrison Street (2nd to Linke)	$ 158,000	1	1	1	1	3	1	1	1	**18**	1B
D-28	South Linke Avenue & Elementary School Loop (Harrison to Polk)	$ 134,000	1	1	1	1	3	1	1	1	**18**	1B
D-29	South Park Street (Polk to Adams)	$ 137,000	1	1	1	1	3	1	1	1	**18**	1B
D-30	West Adams Street (Park to Pine)	$ 38,000	3	1	1	1	2	1	1	1	**18**	1B

Priority 1B Estimated Cost Total
$ 8,854,000

Project Code Legend:
D = Distribution F = Finished Water Line R = Reservoir/Storage S = Water Source/Supply T = Transmission V = Valve Replacement WT = Water Treatment

Footnotes:
1. Project R-1. Periodic inspections are required to document the integrity of the internal coating system. The findings of this inspection may defer or accelerate the recoating project for this facility.
2. Project WT-2. Periodic inspections are required to document the integrity of the internal coating system. The findings of this inspection may defer or accelerate the recoating project for this facility.
3. Project F-2. The large capital cost of this project puts it in a unique caterogy apart from other CIP projects. This is a very important project but funding the full project has the tendency to exclude progress on all other projects. The recommended approach to fund and complete this large project is to setup an annual reserve fund (Project F-1) for interim repairs until the full project (F-2) can be funded.

CITY OF CARLTON WATER MASTER PLAN

TABLE 12-2 CIP PRIORITIZATION MATRIX

Project	Project Description	Estimated Project Cost	Capital Cost	Consequence of Failure	Probability of Failure	Regulatory Compliance	Improves Fire Flow	Improves Water Quality	Improves Operability	Economic Development	TOTAL POINTS	Priority Group
		Weighing Factor (1-3)	1	3	3	2	2	1	1	1		
Priority 2 Improvements			**Matrix Scoring**: Based on a scale of 1 to 4 with 1 being the 'least favorable' and 4 the 'most favorable'									
S-2	Panther Creek Reservoir Dredging & Rehabilitation	$ 2,750,000 [1]	1	1	1	2	1	2	2	1	**18**	2
D-31	West Grant Street (Carr to Yamhill)	$ 157,000	1	1	1	1	3	1	1	1	**18**	2
D-32	North Yamhill Street (Johnson to McKinley)	$ 152,000	1	1	1	1	2	1	1	1	**16**	2
D-33	North Howe Street (Johnson to Lincoln)	$ 70,000	2	1	1	1	2	1	1	1	**17**	2
D-34	North Gilwood Street (Monroe to 4-inch Loop Line)	$ 76,000	2	1	1	1	2	1	1	1	**17**	2
D-35	East Jefferson Street (1st to 4th)	$ 126,000	2	1	1	1	2	1	1	1	**17**	2
D-36	North 3rd Street (Monroe to Jefferson)	$ 95,000	2	1	1	1	2	1	1	1	**17**	2
D-37	West Monroe Street (Scott to Yamhill)	$ 119,000	2	1	1	1	2	1	1	1	**17**	2
D-38	East Monroe Street (4th to 6th)	$ 81,000	2	1	1	1	2	1	1	1	**17**	2
D-39	North 1st Street (Main to Monroe)	$ 70,000	2	1	1	1	2	1	1	1	**17**	2
D-40	North 2nd Street (Main to Monroe)	$ 70,000	2	1	1	1	2	1	1	1	**17**	2
D-41	North 5th Street (Main to Monroe)	$ 70,000	2	1	1	1	2	1	1	1	**17**	2
D-42	Main Street Connections (5th & 6th Street Intersections)	$ 27,000	2	1	1	1	2	1	1	1	**17**	2
D-43	South Kutch Street (Grant to Taft)	$ 124,000	2	1	1	1	2	1	1	1	**17**	2
D-44	West Taft Street (Kutch to Park)	$ 37,000	2	1	1	1	2	1	1	1	**17**	2
D-45	East Taft Street (2nd to 3rd)	$ 38,000	2	1	1	1	2	1	1	1	**17**	2
R-2	Recoating existing 1 MG Steel Reservoir	$ 261,000 [2]	1	1	1	1	2	1	1	1	**16**	2
WT-2	Recoating Existing 0.38 MG Clearwell	$ 189,000 [3]	1	1	1	1	2	1	1	1	**16**	2

Priority 2 Estimated Cost Total
$ 4,512,000

Project Code Legend:

D = Distribution F = Finished Water Line R = Reservoir/Storage S = Water Source/Supply T = Transmission V = Valve Replacement WT = Water Treatment

Footnotes:

1. Project S-2. The urgency and scope of the Panther Creek Reservoir Dredging project is contingent on the findings of the feasibility study associated with project S-1 as well as the annual rate of siltation and the associated decline in water quality.
2. Project R-2. The urgency of the steel reservoir recoating project is contingent on the findings of periodic internal coating inspections as itemized in Project R-1.
3. Project WT-3. The urgency of the clearwell recoating project is contingent on the findings of periodic internal coating inspections as itemized in Project WT-2.

CITY OF CARLTON WATER MASTER PLAN

TABLE 12-2 CIP PRIORITIZATION MATRIX

Project	Project Description	Estimated Project Cost	Capital Cost	Consequence of Failure	Probability of Failure	Regulatory Compliance	Improves Fire Flow	Improves Water Quality	Improves Operability	Economic Development	TOTAL POINTS	Priority Group
		Weighing Factor (1-3)	1	3	3	2	2	1	1	1		
Priority 3 Improvements			**Matrix Scoring**: Based on a scale of 1 to 4 with 1 being the 'least favorable' and 4 the 'most favorable'									
D-46	North Scott Street (North of Monroe)	$ 112,000	2	1	1	1	1	1	1	1	**15**	3
D-47	North Scott Street (Monroe to Main)	$ 79,000	2	1	1	1	1	1	1	1	**15**	3
D-48	South 1st Street (Main to Washington)	$ 114,000	2	1	1	1	1	1	1	1	**15**	3
D-49	East Taylor Street (East of Arthur Street)	$ 99,000	2	1	1	1	1	1	1	1	**15**	3
D-50	South Park Street (South of Taylor)	$ 103,000	2	1	1	1	1	1	1	1	**15**	3
D-51	East Main Street (7th to Modaffari)	$ 248,000	1	1	1	1	1	1	1	1	**14**	3
D-52	South 3rd Street (South of Polk Street)	$ 178,000	1	1	1	1	1	1	1	1	**14**	3

Priority 3 Estimated Cost Total
$ 933,000

Project Code Legend:
D = Distribution F = Finished Water Line R = Reservoir/Storage S = Water Source/Supply T = Transmission V = Valve Replacement WT = Water Treatment

CHAPTER 1

INTRODUCTION

Chapter Outline

INTRODUCTION

CHAPTER 1

1.1 GENERAL OVERVIEW

The City of Carlton is located in Yamhill County, Oregon on Highway 47 approximately 5 miles north of McMinnville airport and 12 miles west of Newberg. The current population of the City Carlton is just over 2,000.

The history of Carlton is tied to an 1870's railroad between Portland and St. Joseph with the site of Carlton being chosen as a railroad stop to serve local farmers. The town of Carlton developed around the railroad stop leading to incorporation in 1899.

Historically Carlton has been primarily an agricultural and residential community with no major industries. The local business base traditionally consisted of retail and service businesses serving the local community. More recently hospitality oriented businesses supporting local tourism, such as wineries and food services businesses have developed.

Based on its proximity to McMinnville and current zoning, it appears that non-residential development in Carlton will be limited to commercial and diversified light industries. Some residential growth has occurred in recent years, although the recent economic slowdown is currently limiting growth. Many of the residents of Carlton work in Portland, McMinnville and other nearby communities. Due to the City's close proximity to these other economic centers and relatively low cost of living, the possibility for continued residential growth exists in the future.

The City owns and operates the public drinking water system and serves the municipal population, as well as the Valley View Water District, the East Carlton Water Company and a number of other customers outside the city limits. The City's primary raw water source is Panther Creek Reservoir which is 9 miles west of town. From Panther Creek Reservoir water is piped approximately 2/3 of a mile east to the City's water treatment plant, located near the intersection of the reservoir access road and Panther Creek Road. The City also has undeveloped water rights on Fall Creek which joins Silver Creek near Von Reservoir, about 3/4 mile southeast of the water treatment plant.

From the water treatment plant the water is piped to the finished water storage reservoirs on the south side of Meadow Lake Road approximately 1.5 miles west of town. The older reservoir is a 380,000 gallon in-ground concrete structure near the road and the newer reservoir is a 1 million gallon welded steel reservoir that sits approximately 400 feet south of the road and is accessed by a gravel driveway. These two reservoirs operate in series with the welded steel reservoir supplying the City with gravity flow through a 10-inch transmission main.

The City's distribution system is currently undersized and poorly interconnected resulting in low fire flow capacities in many areas. Much of the current system was constructed using 4-inch and 6-inch pipes, and even contains a noticeable quantity of 2-inch and 3-inch pipes. More recently larger piping, 8-inch through 12-inch, has been installed with new construction and pipe replacement projects. With regard to materials, much of the older piping is cast iron while later construction has included PVC and ductile iron. The current City Public Works Design Standards call for ductile iron pipe to be used for all new waterlines within the City.

Looking to the future, the City of Carlton along with the cities of McMinnville (McMinnville Water and Light), Dayton and Lafayette jointly formed the Yamhill Regional Water Authority. On January 17, 2013 the Yamhill Regional Water Authority was issued Permit S-54792 authorizing use of 44.18 CFS from the Willamette River. Of this amount 2.98 CFS was requested for the City of Carlton.

1.2 NEED

The City's current Water Master Plan was completed in 1996. The 1996 Water Master Plan outlined recommended improvements to the water system components including the treatment, storage, distribution and transmission systems. A number of the major improvements recommended in the previous Water Master Plan have been addressed.

Some of the reasons for the preparation of a new Water System Master Plan at this time include the following:

- The existing Water Master Plan is now 18 years old. The life and planning horizon for a water master planning document is 20 years, with updates typically recommended on 10 year maximum intervals.
- Some of the key design assumptions used for the existing Water Master Plan have not accurately reflected actual conditions. Most significantly the 1996 Water Master Plan projected a 2016 City population of 3,900, while the current projection anticipates a 2016 population of 2,112. Since population is a highly influential factor in determining infrastructure needs, reviewing the system needs in light of the significant variance between projected vs. actual population growth is necessary.
- Construction, operation and replacement costs for water system components have increased very significantly since 1996 when some of the improvements were recommended. It is appropriate to have a current master planning document that lists recommended improvements together with updated estimates of construction and/or implementation costs. The recommended projects and their associated cost projections can then be included in a capital improvement plan that the City can use to help determine if the current water rates and system development charges (SDC) are appropriate.
- The City's current development standards require findings that adequate capacity is available in the utility systems prior to development occurring. Without a current water system master plan that identifies improvements required with a schedule guiding their construction, implementation of these policies is difficult.

1.3 AUTHORIZATION

In September 2012, the City of Carlton authorized Westech Engineering to begin preparation a new Water System Master Plan.

1.4 PURPOSE

The purpose of this plan is to provide a comprehensive evaluation of the City's water system with respect to its existing and future needs, identify improvements and associated costs necessary to meet those needs, and provide the City with a framework for the provision of water service through the year 2033.

This master plan will assist the City in the planning and implementation of capital improvements, and will assist the development community as the water system is expanded for future growth. The plan will benefit the current and future residents of the City by enhancing the quality of life through improved water quality, planned growth, scheduled improvements, and an equitable distribution of improvement costs.

1.5 Scope Of Work

The scope of work for this project was to update the City's previous Water Master Plan with respect to its existing and future needs, identify appropriate improvements and associated costs necessary to construct those improvements, and to provide the City with a planning document to guide future water system expansion. This plan accomplishes the following specific objectives:

- Establish water system design and planning criteria
- Describe existing and anticipated federal and state drinking water regulatory requirements
- Provide an inventory of the existing water system infrastructure
- Establish water demand projections based on historic and anticipated population
- Evaluate water supply quality and adequacy
- Evaluate the need for modifications to the water treatment facility
- Develop and calibrate a computerized hydraulic model of the City's water distribution system
- Evaluate the existing distribution system to determine required improvements
- Evaluate existing storage reservoirs and perform a system-wide storage analysis
- Evaluate the existing instrumentation and control system
- Develop recommendations for system-wide improvements to enhance reliability
- Develop recommendation for a prioritized Capital Improvement Plan (based on the above evaluations) to correct existing deficiencies and to serve future growth.
- Provide the City with a water system master plan that addresses the concerns of both the City and regulating agencies.

The updated water master plan can be used to develop specific recommendations to the community and City Council for action. This report does not include a wetland inventory or delineation(s), topographic or aerial surveys, on-site environmental investigations or geotechnical investigations.

1.6 Compliance

1.6.1 Master Plan Requirements

Oregon Drinking Water Services (ODWS) requires community water systems with 300 or more service connections to maintain a current water master plan. This plan has been prepared to satisfy the requirements of ODWS as stipulated in OAR 333-061-0060(5).

1.6.2 Future Master Plan Updates

It should be recognized that projections into the future are subject to many variables and assumptions, some of which may prove inaccurate. Accordingly, we recommend that the City review its water system and this master plan at five-year intervals and update the report as appropriate. Updates at 10 year maximum intervals are recommended.

1.7 PREVIOUS STUDIES AND REPORTS

The following reports and studies were referenced in the preparation of this study:

- *Flood Insurance Study, Yamhill County, Oregon*. Federal Emergency Management Agency. March 2010.
- *Yamhill County Water Supply Analysis*. Yamhill County Task Force, by HDR Inc., April 7, 2008.
- *Source Water Assessment Report*. Oregon Department of Human Services, Drinking Water Program (ODWP). September 2004.
- *Intertie for Municipalities in Yamhill County Study*. Economic and Engineering Services, Inc. December 3, 1998.
- *City of Carlton, Oregon, Water Master Plan*. KPFF Consulting Engineers. June 1996.
- *Carlton Comprehensive Plan*. Carlton, Oregon. 2000 (Updated July 2007, June 2009).
- *Population Forecasts for Yamhill County, its Cities and Unincorporated Area, 2011-2035.* Population Research Center College of Urban and Public Affairs Portland State University. October 2012
- *Water Rights Permit S-54792 Final Order*. Oregon Water Resources Department Water Rights Services Division. January 17, 2013.
- *Intergovernmental Agreement Under ORS Chapter 190 By and Between City Of McMinnville Acting By And Through The McMinnville Water And Light Commission And City Of Carlton And City Of Dayton And City Of Lafayette*. December 11, 2012

CHAPTER 2

STUDY AREA AND PLANNING CONSIDERATIONS

Chapter Outline

STUDY AREA AND PLANNING CONSIDERATIONS

CHAPTER 2

2.1 STUDY AREA

The Carlton water system currently provides water service to all areas within the City Limits/UGB, the Valley View Water District, the East Carlton Water Company and a number of individual customers outside the city limits. The primary study area for this water master plan is the entire area within the City Limits/UGB, although the extent of the water system expansion during the study period is not anticipated to extend to the current UGB. The study area also includes the Carlton water system watershed plus water system infrastructure and users located outside the City Limits/UGB. The location of the UGB, City limits and land use zoning designations are shown on **Figure 2-1**.

The City's Comprehensive Plan was most recently published in 2000 with updates in 2007 and 2009. The Comprehensive Plan covers the City Limits and Urban Growth Boundary, which for Carlton is the same. The total area within the City Limits/UGB is 571.4 acres (as measured from CAD maps). Of the 571.4 acres, 207.7 acres are zoned as Agricultural Holding (AH) which is land that is currently undeveloped but available to support future growth.

The improvements recommended in this plan are based on the development of land within the UGB, as well as the existing land use zoning for these areas. It is assumed that no significant development will occur within the study area that will require major changes to the existing zoning, except for the anticipated conversion of AH land to urban uses. This is addressed in Chapter 17.48 of the Municipal Code which states, "*The agricultural holding (AH) district allows an orderly phasing of urban development of land. It is a holding district that allows agricultural uses to continue until such time that the agricultural lands are needed for urban uses and public facilities and services are available*." This study also assumes there will be no significant expansions of the UGB within the study period. Changes in any of these assumptions could change the recommendations contained in this master plan. Should significant changes in any of the above occur, this plan should be updated accordingly.

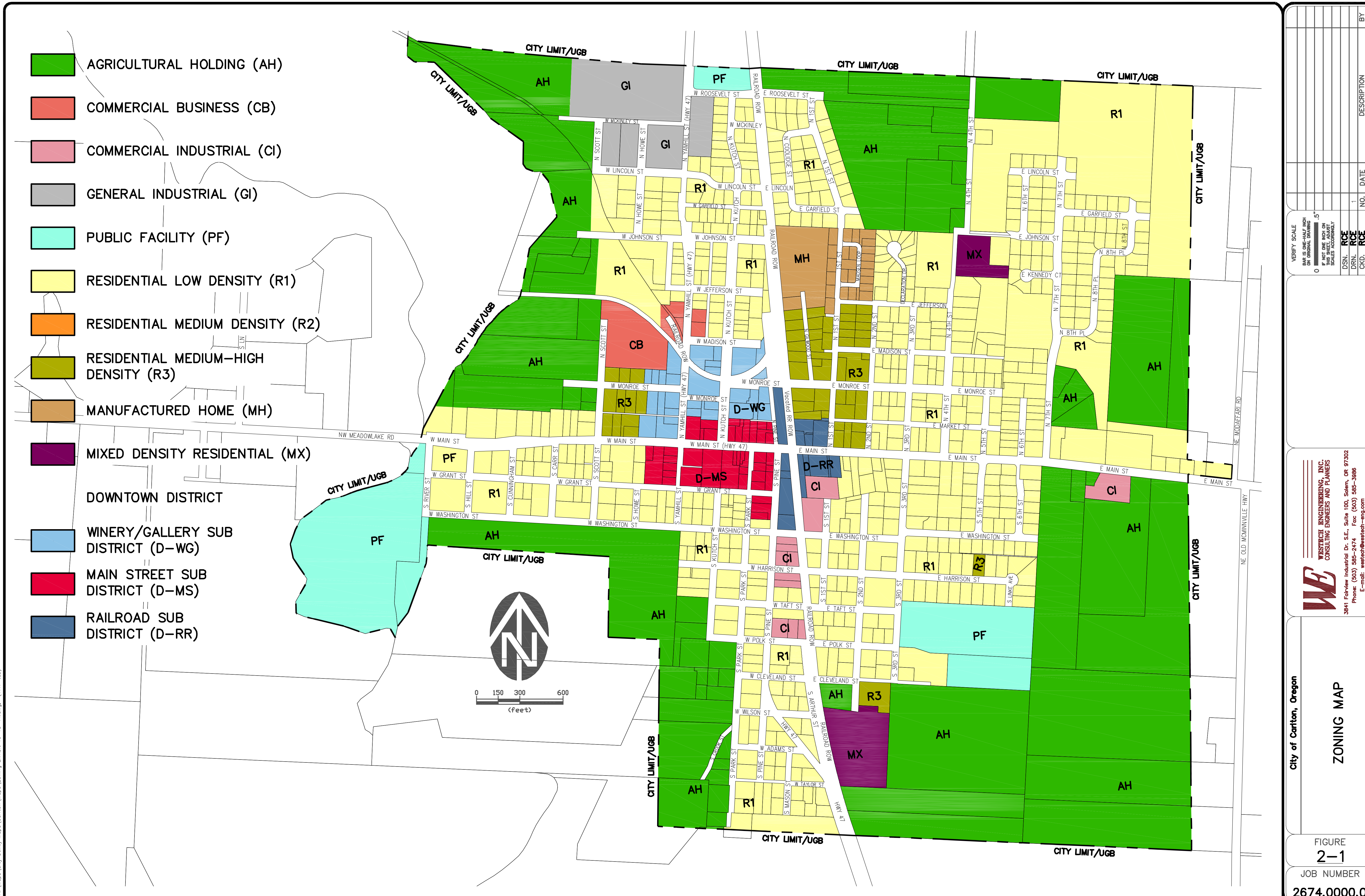
2.2 STUDY PERIOD

Choosing a "reasonable" design period for which a utility system should be designed is a somewhat arbitrary decision. If the design period is too short, the public faces the prospect of demands exceeding capacity, requiring the system to be continually upgraded or replaced.

On the other hand, choosing a design period that is too long can lead to facilities with excess capacity that may never be needed if population growth does not occur at the projected rates. Such facilities can place an economic burden on the present population and may become obsolete before being fully utilized.

The Oregon Health Authority (OHA), Oregon Drinking Water Services (ODWS) has established 20 years as a proper planning period for water system improvements. This report will evaluate the anticipated water supply, treatment, distribution and storage needs for the 20 year planning period. Major transmission pipes are by their nature unsuited for incremental expansion without extensive capital outlays. For this reason, these facilities will be designed for the ultimate development of land within the UGB based on current land use designations. For other facilities such as treatment and storage facilities, a staged approach to expansion may be acceptable.

It should be noted that projections into the future are subject to many variables and assumptions, some of which may prove inaccurate. Accordingly, it is recommended that the City review its water system at five-year intervals and update this report at 10 year maximum intervals (or more frequently if necessary).



AGRICULTURAL HOLDING (AH)
COMMERCIAL BUSINESS (CB)
COMMERCIAL INDUSTRIAL (CI)
GENERAL INDUSTRIAL (GI)
PUBLIC FACILITY (PF)
RESIDENTIAL LOW DENSITY (R1)
RESIDENTIAL MEDIUM DENSITY (R2)
RESIDENTIAL MEDIUM-HIGH DENSITY (R3)
MANUFACTURED HOME (MH)
MIXED DENSITY RESIDENTIAL (MX)
DOWNTOWN DISTRICT
WINERY/GALLERY SUB DISTRICT (D-WG)
MAIN STREET SUB DISTRICT (D-MS)
RAILROAD SUB DISTRICT (D-RR)
CITY LIMIT/UGB
0 150 300 600
(feet)
City of Carlton, Oregon
ZONING MAP
FIGURE
2-1
JOB NUMBER
2674.0000.0
WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com
DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13
NO. DATE DESCRIPTION BY
REVISIONS

2.3 PHYSICAL ENVIRONMENT

2.3.1 Climate and Rainfall Patterns

The study area is located in the Willamette Valley along the eastern foothills of the coast range. Since there is no National Weather Service recording station in Carlton, rainfall and temperature data were examined from several weather stations including McMinnville, Hillsboro, Beaverton, and the OSU North Willamette Experimental Station near Wilsonville. Overall these stations exhibit similar climate patterns, and with Carlton being in the center of the group, a reasonable approximation for Carlton's climate can be developed.

The climate in Carlton is relatively mild throughout the year, characterized by cool, wet winters and warm, dry summers. The study area has a predominant winter rainfall climate. Typical distribution of precipitation includes about 50 percent of the annual total from December through February, lesser amounts in the spring and fall, and very little during summer. Rainfall tends to vary inversely with temperatures -- the cooler months are the wettest, the warm summer months the driest.

The study area receives an average of approximately 40 inches of precipitation annually, with the majority of the rainfall occurring during the winter months. Precipitation extremes are somewhat difficult to verify because rainfall records are not always complete. The referenced stations have been in operation for differing periods of time: McMinnville (1894-present, Average Rainfall: 41.81 inches), Newberg-Rex 1S (1948-present, Average Rainfall: 43.05 inches) and Hillsboro (1929-2003, Average Rainfall: 37.74 inches). The wettest year recorded for McMinnville was 1896 with an accumulation of 64.92 inches while 1996 was the wettest year for Newberg (73.63 inches) and Hillsboro (61.03 inches). The referenced stations have experienced their driest years at different times: McMinnville (1929, 23.58 inches), Newberg-Rex 1S (1985, 25.03 inches) and Hillsboro (1930, 23.70 inches). Approximately 3/4 of the annual precipitation occurs between November 1 and April 30. July and August are typically the driest months with an average rainfall for the month of less than one inch.

Extreme temperatures in the study area are rare. Days with maximum temperature above 90°F occur only 5-15 times per year on average, and below 0°F temperatures occur only about once every 25 years on average. Mean high temperatures are around 80°F in the summer dropping to the mid 40s in the coldest months, while average lows are generally in the low 50s in summer and low 30s in winter.

Although snow falls nearly every year, amounts are generally quite low. Willamette Valley floor locations average 5-10 inches per year, mostly during December through February. High winds occur several times per year in association with major weather systems.

Relative humidity is highest during early morning hours. During the afternoon, humidity is generally lowest, ranging from 70-80 percent during January to 30-50 percent during summer. Annual pan evaporation is about 35 inches, mostly occurring during the period April through October.

Winters are likely to be cloudy. Average cloud cover during the coldest months exceeds 80 percent, with an average of about 26 cloudy days in January (in addition to 3 partly cloudy and 2 clear days). During summer, however, sunshine is much more abundant, with average cloud cover less than 40 percent; more than half of the days in July are clear.

2.3.2 Topography

Carlton is located on the western edge of the Willamette Valley just east of the North Yamhill River approximately 6 miles upstream of the point where the North Yamhill River joins the South Yamhill River in northeastern McMinnville. The City sits on a low ridge that runs between the North Yamhill River and Hawn Creek. Roughly the eastern part of town drains into Hawn Creek while the west side drains to the North Yamhill River. The high point of the ridge generally corresponds to the vicinity of Highway 47. On the west side the topography also generally divides north-south in the vicinity of West Main Street. Moving east the north-south divide shifts a little north to the vicinity of Market and Monroe Streets. There is also a section in the northeast part of town that is east of Hawn creek.

Overall the topography within the City Limits generally is gently sloping and undulating within the main section of town. For the most part slopes throughout the City Limits are on the order of 5-6% or less. In some limited areas, primarily near the river and creek, the ground slope increases to 10-20%. Low elevations generally range from 120-130’ along the banks of the North Yamhill River and from 150-160’ along the banks of Hawn Creek. From these location the ground rises to high elevations in the range of 190-200’ along Highway 47, with the highest elevations just over 200’ Similarly, in the northeast area the ground slopes up to the north and east from Hawn Creek to just over 200’.

There are several other areas of interest within the study area to be considered including the areas served east and south of town, along Meadow Lake Road and Panther Creek Road, the storage reservoir sites, the treatment plant site and the Panther Creek reservoir and associated watershed. The topography of the area served by the Valley View Water District was not reviewed as the District operates it system independently from the City’s water system.

The area south of town extends along Highway 47 for approximately 1/2 mile from the City limits in terrain similar to that described for the City Limits. East of town (served by the East Carlton Water Company) the topography is also similar to that in town except that as you move out to the farthest northeast part of this area the ground continues to rise to elevations just under 300’.

Moving west from town along Meadow Lake Road the terrain generally become hillier. About 1.5 miles west of town the road passes across a saddle between two hills where the roadway elevation rises to a little under 360’. The two storage reservoirs are on the hill south of the roadway in this area. Continuing west the roadway rises and falls as it runs along the base of the hills adjacent to small creek valleys. About four miles west of town Panther Creek Road intersects Meadow Lake Road at an elevation of about 200’, similar to that at the center of town. Panther Creek Road follows Panther Creek running generally west and northwest for nearly four miles to the intersection of the Carlton Reservoir access road at an elevation of approximately 450’. The access road continues adjacent Panther Creek for about 3/4 of a mile to the dam which is at an elevation of about 585’. This route is important because the transmission main runs from the reservoir to town generally along this route.

The topography of the Carlton Reservoir watershed includes roughly 2,100 acres generally west and southwest of the reservoir. The terrain in the watershed is generally mountainous rising quickly from Panther Creek and its tributaries with slopes of 30-40% common and many areas much steeper than that. The reservoir water surface is at about 582’ at full pool and the ground rises to the highest elevations over 2,000 feet roughly 2 miles to the west and southwest.

2.3.3 Soils

Although a detailed analysis of the soils and geology is outside the scope of this report, one soil characteristic evaluated by the Soil Conservation Service was the drainage capacity of the soils. The major soil association within the study area is the Woodburn-Willamette association, and the predominate soil type in the Carlton area are alluvial deposits of Woodburn silt loam. This soil typically is moderately permeable to water in the upper layers, and slowly permeable in the lower layers. This discussion on soil types are based from the Soil Survey of Yamhill County, Oregon (January 1974) prepared by the Soil Conservation Service (now the Natural Resource Conservation Service) showing the approximate locations of the Yamhill County soil types. The reader is referred to the Yamhill County Soil Survey for detailed definitions and descriptions of the individual soil designations. Soil types within the City Limits/UGB are shown on **Figure 2-2.**

2.3.4 Water Resources

There are two classes of water resources within the study area, namely surface water and groundwater. Surface water includes all drainage channels that convey storm and surface runoff. This includes Panther Creek, Fall Creek and the North Yamhill River as well as a variety of other creeks and tributaries not currently used by the City for water supply. While technically not in the study area, the Willamette River is also a surface water resource for Carlton through the Yamhill Regional Water Authority. Groundwater is accessed using wells but is not currently a source of supply used by the City. The Oregon Department of Water Resources regulates the use of both surface and groundwater resources.

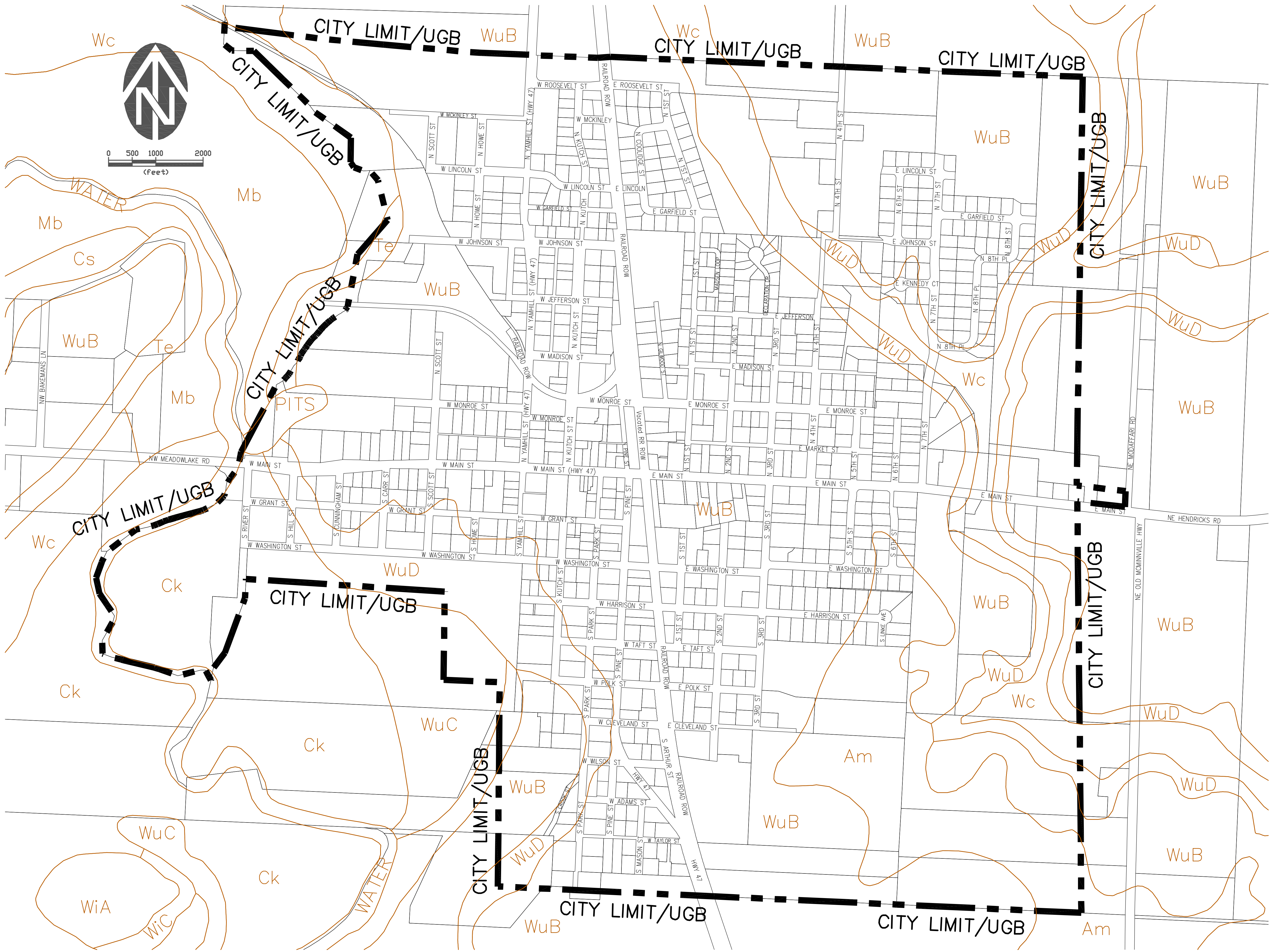
Drinking water for Carlton is currently comprised entirely of a single surface water source at the Carlton Reservoir on Panther Creek. This source is subject to high turbidity during large rainfall events but is otherwise a comparatively high quality and highly reliable source. Additional undeveloped surface water sources for the City include Fall Creek and also as mentioned above the Willamette River as part of the Yamhill Regional Water Authority. An in-depth discussion of the City's surface water sources and water rights is presented in Chapter 4.

2.3.5 Geologic Hazards

Known geologic hazards within the study area include localized steep slopes, flooding, and seismic concerns.

2.3.5.1 Seismic

The current building code (Oregon Structural Specialty Code) drives seismic structural design criteria based on longitude and latitude of the proposed building site. If the alternative(s) selected by the City include the construction of buildings or other significant structures, a detailed geotechnical report will be required prior to design. Therefore, a more detailed review of local geology and faulting, as well as seismic and settlement considerations specific to the site selected, may be deferred until any required predesign reports.



8/27/2013 1:51:12 PM
R:\Maps\City Utility Maps\Carlton\Maps\Water MP Exhibits\2-2 Soils Map 07-08-13.dwg, (1117 tab)

NO.	DATE	DESCRIPTION	BY
		REVISIONS	

VERIFY SCALE
BAR IS ONE-HALF INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

City of Carlton, Oregon

SOIL MAP

FIGURE
2-2

JOB NUMBER
2674.0000.0

2.3.5.2 Flooding

The North Yamhill River is the primary stream and Hawn Creek is the only other significant stream within the City Limits/UGB portion of the study area. Carlton is located on the east bank of the North Yamhill River approximately 9 river miles upstream from the Yamhill River. The North Yamhill River runs generally north to south past the City and continues generally south to McMinnville. Hawn Creek traverses the northeast quadrant of the City and continuing south it joins the Yamhill River between river mile 4.9 and 5.0 (approximate).

The Yamhill River has a streamflow pattern similar to other Willamette Valley streams. It is typified by high flows during the winter and low flows during the summer months. The portion of Hawn Creek within the study area is just below the upper reaches of the stream such that it is frequently virtually dry during the summer months.

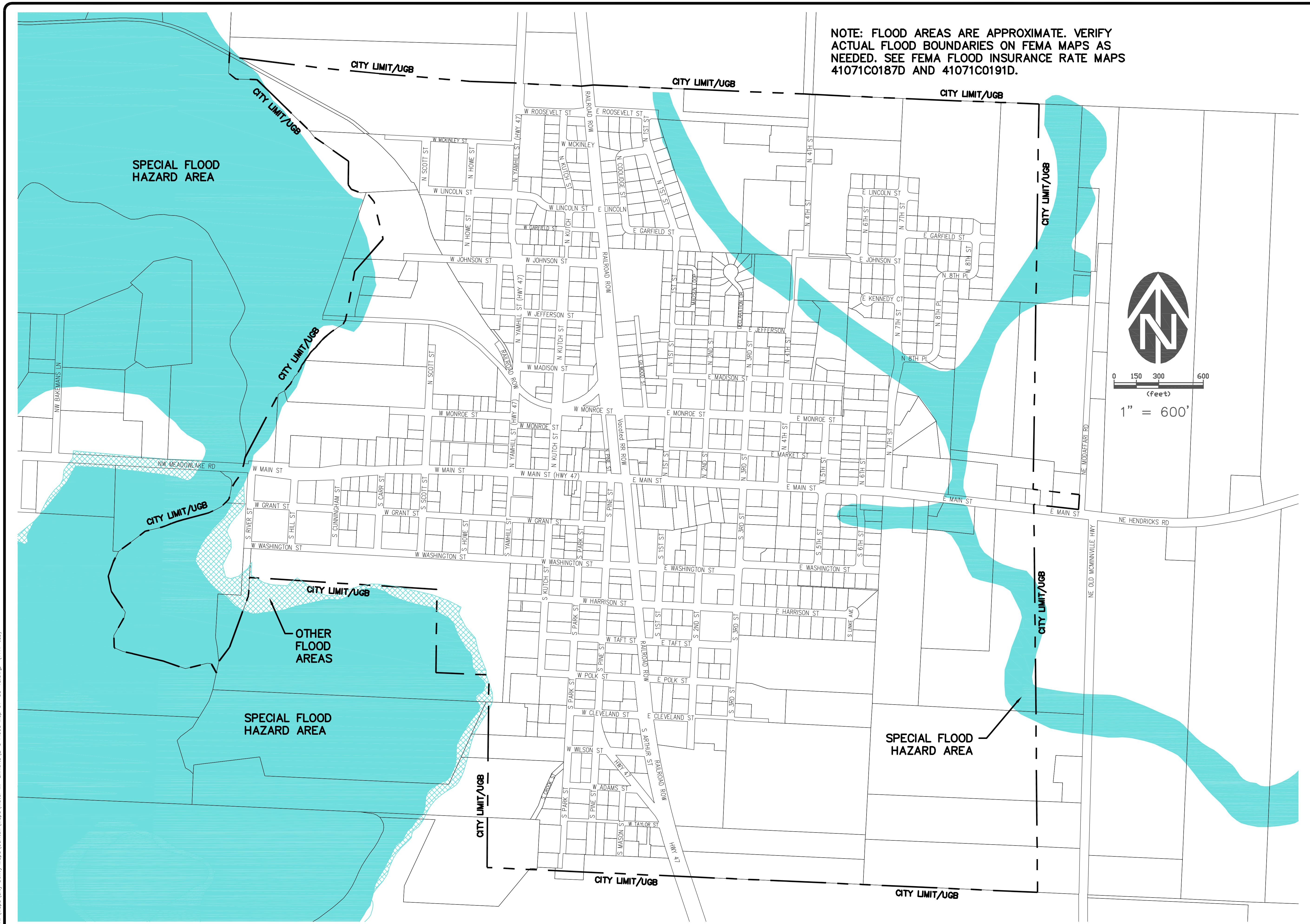
The Federal Emergency Management Agency (FEMA) has established a 100-year floodplain designation and insurance ratings for the study area. While sometimes referred to as the “100 year flood”, it is more accurate to consider it the flood having a 1 percent chance of occurrence in any year, or a 10 percent chance of occurrence during any 10 year period.

During a 100-year flood (as defined by FEMA), the North Yamhill River and Hawn Creek rise out of their normal channels creating a floodplain. Flood profiles and maps for those portions of the North Yamhill River are included in the Flood Insurance Study prepared for the Yamhill County and include City of Carlton. The current FEMA maps were issued with an effective date of March 2010, and the relevant flood boundaries are illustrated on **Figure 2-3**.

It should be noted that the Floodplain and Floodway boundaries shown on the FEMA flood maps are based on flood elevations, and as such the actual boundaries may vary slightly from the location shown. Final determinations of whether property is within the floodway or floodplain must be determined based on a topographic survey of the property in question. Due to the topography of Carlton, most of the land within the City limits is out of the flood plain except for a few locations that are very close to the Yamhill River and Palmer Creeks.

It should also be noted that the elevations shown on the new FEMA flood maps are based on the NAVD 1988 vertical datum, whereas the old FEMA maps were based on the NVGD 1929 vertical datum. However, the actual flood elevations shown on the new FEMA flood maps are essentially the same as shown on the old maps. Therefore, while the flood elevations listed on the new FEMA maps are about 3.4 feet higher than those shown on the old maps, this is due to the datum change and not to changes in the actual flood elevations.

The intent is to update the City’s Public Works Design Standards (PWDS) to require that public infrastructure designs be based on the newer 1988 vertical datum, in order to match with the FEMA flood elevations. However, most of the old design drawings prepared prior to March 2010 are based on the 1929 vertical datum, and elevation conversions are required when comparing these drawings against current FEMA flood elevations.



City of Carlton, Oregon

FLOOD BOUNDARY MAP

FIGURE 2–3

JOB NUMBER 2674.0000.0

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

VERIFY SCALE: BAR IS ONE-HALF INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

8/27/2013 1:51:22 PM
R:\Maps\City Utility Maps\Carlton\Maps\Water MP Exhibits\2-3 Flood Map 07-08-13.dwg, (1117 tab)

2.3.5.3 Steep/Unstable Slopes

The only areas of potential slope stability concerns within the City Limits/UGB portion of the study area are the comparatively small areas of steep slopes (>20%) near the North Yamhill River and Hawn Creek. Steep slopes can have the potential for either mass movement or slope erosion. Mass movement results from shifting of rock or soil material in response to gravity, such as landslides and rock slides. These mass movements are often precipitated or aggravated by excessive groundwater. Slope erosion is the removal of soils or rock that occurs as a result of sheet flow, resulting in surface erosion or gully erosion. This is primarily caused by private land use practices (mainly land clearing and road construction) that can exacerbate slope erosion.

Although this area shows no signs of recent movement, the steep slopes near the North Yamhill River and Hawn Creek can be considered a geologically sensitive area for siting critical facilities, such as pump stations, reservoirs, or treatment plants.

2.3.5.4 Stream Erosion

As is common with most valley bottom streams, the North Yamhill River and Hawn Creek channels are continuously eroding and re-depositing bank material. This is especially prevalent on the outer bends of the river where undercutting and caving of the banks is common within the study area. The potential for stream bank erosion is an important design issue that must be carefully considered for facilities sited near the Yamhill River and Palmer Creek.

2.3.6 Public Health Hazards

Discussions with City staff have not revealed any known or documented chronic public health hazards within the study area.

2.3.7 Air Quality and Noise

2.3.7.1 Air Quality

The existing air quality in the study area is generally good. Agricultural, slash and field burning can be significant intermittent air pollution sources, primarily during July and August. During cold periods with stagnant air, residential wood heating may impact local air quality. There are no known air quality monitoring stations located within the study area.

2.3.7.2 Noise

There are no significant generators or sources of noise in the Carlton study area. Noise levels are low and do not exceed DEQ standards. Noise sources within the study area are largely limited to vehicular traffic. None of the alternatives evaluated herein are expected to generate significant noise.

2.3.8 Environmentally Sensitive Areas

2.3.8.1 Riparian Zone

Riparian zones include the riparian zone adjacent to the North Yamhill River and creeks, as well as incidental riparian zones that are a part of the intermittent drainage channels found throughout the study area. Riparian zones are considered sensitive due to the variety of vegetative and wildlife species that utilize these areas as habitat. Riparian zones provide erosion control, drainage and runoff water quality management, wildlife habitat, and shading for surface waters.

2.3.8.2 Wetlands

Wetlands are considered to be one of the most biologically productive components of the environment. Their functions and value include primary production, fish and wildlife habitat, flood control, water quality improvement and erosion control and point of entry for groundwater recharge. Detailed wetland surveys or delineations are not included in the scope of this study.

The methodology for determining wetland areas is based on the Army Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory, 1987), used by the U.S. Army Corps of Engineers and the Oregon Division of State Lands (DSL). The regulatory definition of wetlands in the 1987 Manual requires that, under normal circumstances, positive indicators of wetland hydrology, hydric soil, and hydrophytic vegetation are present. Wetlands are defined as areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas, but also include seasonal wet meadows, farmed wetlands and other areas that may not appear “wet” all the time. Wetland determinations consist of documenting three criteria: hydrophytic (water-tolerant) vegetation, hydric (wet) soils, and wetland hydrology.

The Oregon Division of State Lands (DSL) is responsible for developing and maintaining the Statewide Wetlands Inventory (SWI). The inventory consists of two types of inventories - the National Wetlands Inventory (NWI) developed by the U.S. Fish and Wildlife Service and Local Wetlands Inventories (LWI) developed by cities according to standards set by the DSL.

The National Wetlands Inventory (NWI) was developed by the U.S. Fish and Wildlife Service (FWS) and is available statewide. Wetlands and deepwater habitats (streams, lakes, estuaries, etc.) are mapped on a USGS quad map base; most are at a scale of 1:24,000. Only those wetlands and other waters that are visible on high altitude aerial photographs are mapped, and most maps date to the mid-1980s. There are 1,865 maps for Oregon. These maps are available from the Oregon Division of State Lands (DSL). The NWI completed in 1994 for Carlton (Carlton quad) delineates wetlands along the Yamhill River and some small portions of land located outside of town

Local Wetlands Inventories (LWIs) are comprehensive maps and information about wetlands throughout a city. They supplement the National Wetlands Inventory in urban areas. However, at this time Carlton has not completed a local wetland inventory map for the City.

Wetlands can affect the master planning effort if the land within the UGB contains a substantial amount of wetlands. Carlton has very little wetland area mapped within the UGB, and areas that do have wetlands nearby are typically near steep slopes or in the flood plain, and are therefore mostly undevelopable. Construction work that impacts wetland areas is subject to additional permit requirements.

2.3.8.3 Historical and Archaeological Sites.

The modern history of Carlton dates to 1844 with the Peter Smith land claim on the town site. In 1874 a railroad station was constructed and the town began to develop with incorporation occurring in 1899. A number of buildings and structures throughout town are included on the National Register of Historic Places.

The mid-Willamette Valley was inhabited with the Calapooia people when the first western settlers arrived in the mid 1840’s. It is also likely that prehistoric people inhabited the study area at one time.

Remains of these cultures may exist adjacent to the North Yamhill River and its tributaries. Therefore, an archaeological assessment may be required during the predesign phase, especially in areas adjacent to the river, if required by funding agencies.

2.4 FLORA AND FAUNA

2.4.1 Flora

The natural vegetation within the primary study area that includes the City Limits/UGB has been largely replaced by rural residential or agricultural (pasture or seed grass) uses. The area is capable of supporting lowland meadows or forests but to a large extent these have been replaced. Typical native vegetation along lowland areas include such tree species as Douglas fir, Western Red Cedar, Big leaf maple, Vine Maple, California black cottonwood, Pacific yew, ash, Oregon oak, and Hawthorn. Shrubs that can be found are Snowberry, Indian plum and Western hazel. Willows and various grasses are also found in this habitat.

2.4.2 Fauna

A variety of wildlife species are found within the study area. The only big game species found in the study area is the black-tailed deer. Several species of birds and small animals are found in and around the study area. Included in this group are ring-necked pheasant, turkeys, grouse, quail, waterfowl, doves, pigeons, and several varieties of song birds.

Forest cover and riparian areas provide the habitat necessary for most big-game, bird, and small animal species. The agricultural areas within the study area provide feeding and cover for a variety of waterfowl and song birds.

The North Yamhill River and many of its tributaries are important habitat for a variety of fish. Common fish species found include largemouth bass, rainbow trout, coastal cutthroat trout, dace and sculpin as well as anadromous salmonids, including coho salmon, chinook salmon and steelhead.

2.4.3 Threatened or Endangered Species.

Fieldwork to identify the presence of threatened and endangered species habitat in the study area is beyond the scope of this study. However, several threatened and endangered species may inhabit the study area. In particular the City should be aware of the existence of the Fender’s Blue Butterfly in the areas west of town. Therefore, detailed investigations to determine if a particular project impacts threatened and endangered species should be performed early in the design phase for each project. The one exception to this would be for waterlines located in paved or otherwise previously developed areas.

2.5 ENERGY PRODUCTION & CONSUMPTION

There are no water system components or proposed improvements intended to produce electricity or other energy sources. With regards to energy consumption, the major energy consumers in a water treatment and distribution system are the electric motors required to drive pumps and other equipment. It is recommended that these components be specified as having high or premium efficiency motors, which will reduce the operating costs over the life of the project. Depending on the current programs in place with the electric utility providing service, there may be rebates available if high/premium efficiency electrical motors are specified, which will tend to offset the slightly higher capital construction cost.

2.6 Socio-Economic Environment

Growth within the study area will depend on socio-economic conditions within the City. The following section contains a general discussion of economic conditions, trends, population, land use, and public facilities relating to both the study area and the City.

2.6.1 Economic Conditions and Trends

Population growth and the resultant water demands within the study area are linked to the economic conditions and trends of the City and the McMinnville and Newberg areas. Carlton is an attractive town with a rural atmosphere that offers more affordable housing options than Newburg and McMinnville. Because of that Carlton is to some extent evolving into a bedroom community for persons employed in Newburg and McMinnville. With limited significant industrial or commercial growth expected in the near future, this characterization is likely to remain valid throughout the planning period.

As with many other communities in the area, Carlton experienced more rapid levels of development during the years before the recession hit. Due to the poor economy development is anticipated to be slow in the immediate future and slowly increase in the future.

2.6.2 Population & Growth Projections

2.6.2.1 Municipal Population Base

Based on US Census data, Carlton’s population in the year 2010 was 2,007 people. Based on population estimates prepared by the PSU Population Research Center, the population had increased to approximately 2,036 by 2011 and 2,065 by 2012. The municipal population is expected to grow to 2,806 by the year 2033. A more in-depth discussion of population projections is presented in Section 5.3.

2.6.3 Land Use Regulations

2.6.3.1 Comprehensive Plan

All of the land within the planning area is within the Carlton UGB. The City’s Comprehensive Plan was adopted in 2000, and was most recently revised in 2009.

2.6.3.2 Land Use Zoning

Eventually the entire area within the City Limits/UGB will be served by the City's utility systems. Of the roughly 475 acres of zoned land in the City Limits/UGB approximately 43% is zoned for residential uses, 6% for commercial uses, 2% for industrial uses, and 6% for public uses, while 42% remains reserved for future development. The location of the UGB/City Limits and the land use zoning designations within the City are shown in **Figure 2-3.** The total areas contained under each zoning designation are listed in **Table 2–1**.

Table 2-1 Approximate Areas by Land Use Zone

Land Use Category	Area (Acres)
Residential-Low Density (R-1)	186.1
Residential-Medium Density (R-2)	0
Residential-Medium High Density (R-3)	12.6
Manufactured Home (MH)	7.3
Mixed Density Residential (MX)	6.6
Downtown (D)	
Historic Main Street (D-MS)	7.3
Winery Gallery (D-WG)	7.0
Railroad (D-RR)	3.8
Commercial Business (CB)	4.8
Commercial Industrial (CI)	4.5
General Industrial (IG)	12.0
Public Facility (PF)	30.4
Agricultural Holding (AH)	199.2
Total Zoned Area w/in City Limits/UGB	474.7
Public Right-of-Way	89.8
TOTAL Area w/in City Limits/UGB	571.4

CHAPTER 3

REGULATORY REQUIREMENTS

Chapter Outline

REGULATORY REQUIREMENTS

3.1 INTRODUCTION

This chapter provides a summary of the key regulatory requirements and standards that govern the operation of the City's water system, and which form the basis of the master planning effort. These regulations include both water quality and water use standards. This overview is for general reference only and may not include all requirements.

3.2 REGULATING AGENCIES

The Oregon Health Authority (OHA), Oregon Drinking Water Services (ODWS) is the primary regulating agency for water quality standards related to public drinking water systems.

Water rights and water use regulations are administered by the Oregon Water Resources Department (OWRD).

3.3 EXISTING WATER QUALITY REGULATIONS

Congress passed the original Title XIV of the Public Health Service Act, commonly known as the Safe Drinking Water Act (SDWA), in 1974. The SDWA and subsequent amendments are federal water quality regulations affecting all public water purveyors. Regulations under the SDWA at the federal level are promulgated by the US Environmental Protection Agency (USEPA). The requirements of the SDWA and amendments are implemented by the State of Oregon under the Oregon Drinking Water Quality Act of 1981 (ORS 448 as amended). This legislation allowed the State to gain primacy for enforcing the federal rule requirements and the responsibility of maintaining and enforcing a drinking water program.

ODWS periodically publishes an overview of drinking water quality standards. The most current version of this overview is published in Volume 21, Issue 4, Fall 2006 of the Pipeline newsletter and is included in **Appendix A**. The newsletter provides a listing of contaminant MCLs, treatment techniques, and a detailed account of regulatory history.

The USEPA and ODWS currently enforce drinking water standards for 91 primary contaminants and 15 secondary contaminants. Primary standards regulate contaminants that pose a serious risk to public health whereas secondary standards cover aesthetic considerations. Public water systems must sample for primary contaminants routinely to ensure that standards are met, and report results of that sampling to the regulating agency.

Primary contaminants can be grouped into the following general groups. A discussion of each will be presented in this section.

- Microbial contaminants
- Disinfectants and disinfection byproducts
- Inorganic chemicals
- Organic chemicals
- Radiologic contaminants

Control of each contaminant is administered through a proscribed list of standards or limits that take several forms.

- *Maximum Contaminant Level Goal (MCLG)* — The level of a contaminant in drinking water below which there is no known or expected risk to health, allowing for a margin of safety. All regulated contaminants have an MCLG, although the MCLG is not enforceable.
- *Maximum Contaminant Level (MCL)* — The highest level of a contaminant allowed in drinking water, set as close to the MCLG as feasible using the best available treatment technologies.
- *Treatment Technique (TT)* — A required treatment process intended to reduce the level of a contaminant in drinking water. Contaminants for which testing or monitoring is not economically or technically feasible are regulated by the establishment of a treatment technique. Treatment techniques represent a requirement to install and operate a treatment process that has a proven efficacy for contaminant reduction. Performance standards (PS) are used to determine whether or not a water system is meeting a specific treatment technique requirement and consist of measurements of water quality parameters such as turbidity, disinfectant residual, pH, or alkalinity.
- *Action Level (AL)* — The concentration of a contaminant, which when exceeded, triggers treatment or other requirements that a water supplier must follow.

Water systems that use groundwater sources are governed by a different set of water quality requirements than those that use surface water sources. A third category of source water, regulated under the same standards as surface water, is groundwater under the direct influence of surface water (GWUDI). ODWS defines GWUDI as "any water beneath the surface of the ground with significant occurrences of insects or other macro-organisms, algae or other large-diameter pathogens such as *Giardia lamblia* or *Cryptosporidium*, or significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity or pH which closely correlate to climatological or surface water conditions". An evaluation of surface water influence can involve geological assessments or water quality analysis, depending on the determination of ODWS. Such investigations or re-evaluations can be made at any time based on changing conditions. If sources that are determined to be potentially GWUDI cannot be upgraded to preclude surface water influence, those sources will be regulated by GWUDI water quality standards.

3.3.1 Microbial Contaminants

Pathogenic microorganisms in drinking water can be divided into three groups: bacteria, protozoa, and viruses. Pathogenic microorganisms have a number of specific properties which distinguish them from chemical contaminants; they are living organisms and are not dissolved in water, although they will coagulate or attach to colloids and solids in water.

Regulatory inactivation or removal of these three groups of microorganisms is predominantly determined by the nature of the water source. In general, municipalities using surface water or GWUDI sources are required to inactivate or reduce all three sources, while those using groundwater are required to provide for inactivation of viruses.

Bacteria

Coliforms are a broad class of bacteria which live in the digestive tracts of humans and many animals. Although many types of coliform bacteria are harmless, some cause gastroenteritis, a general category of health problems that includes diarrhea, cramps, nausea, and vomiting. Gastroenteritis is not usually serious for a healthy person, but can cause serious problems for people with weakened immune systems such as the very young, elderly, or immune-compromised. Outside the colon, coliforms only survive for approximately 48 hours. Common bacteriological pathogens responsible for waterborne disease include *Escherichia coli (E. coli), Legionella, Salmonella typhi, Shigella*, and *Vibro cholerae*.

Protozoa

Protozoa are single-cell organisms. They have a complex metabolism and feed on solid nutrients, algae, and bacteria present in multiple-cell organisms, such as humans and animals. To survive harsh environmental conditions, some species can secrete a protective covering and form a resting stage called a cyst, a condition that can protect some protozoa from conventional chlorine disinfection. Common examples of parasitic protozoa are *Giardia lamblia* and *Cryptosporidium*.

Viruses

Unlike bacteria and parasitic protozoa, viruses can only replicate in living host cells and are inactive for periods outside of the host organism. Due to their small size, viruses can pass through conventional filtration processes and are accordingly typically inactivated with chlorine. Common examples of waterborne viruses include hepatitis A, rotavirus and Norwalk virus.

3.3.1.1 Microbial Contaminant Regulations

Several regulations have been promulgated over the years to prevent microbial contamination of drinking water supplies. These include the following regulations:

- Total Coliform Rule (TCR)
- Revised Total Coliform Rule (RTCR)
- Surface Water Treatment Rule (SWTR)
- Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR)
- Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)

3.3.1.2 Total Coliform Rule

Initially published in 1989 the Total Coliform Rule (TCR) applies to all public water systems and establishes health goals—in the form of maximum contaminant level goals (MCLGs), and legal limits—in the form of maximum contaminant levels (MCLs) for total coliform levels in drinking water. The goal of the TCR is to maintain microbial quality in finished and distributed drinking water supplies. Therefore, it primarily applies to the distribution system. It requires systems to sample for coliform bacteria which are used as an indicator of whether a water system is vulnerable to pathogens. Coliforms were also selected because they are easily detected in water.

In promulgating the TCR, the EPA set the maximum contaminant health goal (MCLG) for total coliforms at zero. ODWS stipulates the total number of water samples a PWS must test each month and limits the number of “coliform-present” samples within this routine collection set. The number of routine samples is dependent on population.

Based on a current (2013) population of approximately 2,065 the City is required to collect two (2) monthly samples. Samples must be taken from an approved set of locations throughout the distribution grid, and the number of "coliform-present" results is limited to a single sample.

If a sample tests positive for coliforms, the system must collect a set of repeat samples within 24 hours. A "coliform-present" test result on either a routine or repeat sample constitutes a non-acute violation and requires additional testing for fecal coliforms and *E. coli*. A positive result for either fecal coliform or *E. coli* constitutes an acute MCL violation. Public notification is conducted in accordance with OAR 333-061-0042, which outlines a tiered approach commensurate with the proscribed risk level of a given violation.

Compliance for the TCR is based on a monthly cycle measured on two levels: submitting the proscribed number of samples, as well as successful test results for the absence of total coliforms in a given test cycle. Once in recent years, the City has been cited for not reporting the required number of coliform samples. For this study, the last 10 years of coliform data was reviewed. In that time, none of the samples collected by the City have been "coliform-present."

3.3.1.3 Revised Total Coliform Rule

The Total Coliform Rule (TCR) was initially published in 1989 and was recently revised in February, 2013. With the new rules so recently issued detailed guidance for operators is limited. The April 2013 DWP Pipeline newsletter states, "As anticipated EPA guidance documents become available, we will be sharing information with all of you."

The Revised Total Coliform Rule (RTCR) applies to all public water systems and establishes health goals- in the form of maximum contaminant level goals (MCLSs), and legal limits- in the form of maximum contaminant levels (MCLs) for *E. coli* in drinking water. The goal of the RTCR is to maintain microbial quality in finished and distributed drinking water supplies. Therefore, it primarily applies to the distribution system. It requires systems to sample for *E. coli* bacteria which are used as an indicator of whether a water system is vulnerable to pathogens.

In promulgating the RTCR, the USEPA set the MCLG and MCL for *E. Coli* at zero (0), and eliminated the MCLG and MCL of zero for total coliform, replacing it with a treatment technique for coliform that requires assessment and corrective action. *E. coli* is a more specific indicator of fecal contamination and potential harmful pathogens than total coliform (many of the organisms detected by total coliform methods are not of fecal origin and do not have any direct public health implications).

Under the newly adopted treatment technique for coliform, total coliform serves as an indicator of a potential pathway of contamination into the distribution system. A public water system that exceeds a specified frequency of total coliform occurrence must conduct an assessment to determine if any sanitary defects exist and, if found, correct them. In addition, a water system that incurs an *E. coli* MCL must conduct an assessment and correct any sanitary defects found.

The City must comply with the RTCR by April 2016. Until then the City must maintain compliance with the existing TCR.

3.3.1.4 Surface Water Treatment Rule

The SWTR was promulgated in 1989. It applies to all public water systems using surface water or GWUDI. This includes Carlton's system. The primary purpose of the SWTR is to provide public health protection from microbial contaminants including bacteria, protozoa, and viruses. Specific provisions of the SWTR include the following.

- All systems that use surface water or GWUDI must disinfect water before discharging into the distributions system.
- All systems that use surface water or GWUDI must filter unless avoidance criteria can be met.
- All systems that use surface water or GWUDI must reliably achieve 3-log (99.9%) removal and/or inactivation of *Giardia lamblia.*
- All systems that use surface water or GWUDI must reliably achieve 4-log (99.99%) removal and/or inactivation of viruses.
- Establishes turbidity performance standards for combined filter effluent.
- Establishes a minimum disinfectant residual of 0.2 mg/L at the entry point to the distribution system and requires that minimum detectable levels of disinfectant must be maintained at all locations in the distribution system.

Since it is not practical to measure concentrations of *Giardia lamblia* and viruses on a regular basis, the SWTR established performance standards to ensure the removal requirements for these contaminates are achieved. Different treatment technologies are assigned a log removal credit for *Giardia lamblia*. For Carlton's plant, a 2-log removal credit is granted for the direct filtration system. As noted above, the SWTR requires a 3-log removal credit. Therefore, Carlton's disinfection system is operated to provide a 1-log removal credit to meet the total 3-log removal requirement for *Giardia lamblia.*

The EPA has published tables of minimum CT (disinfectant concentration x contact time) required to achieve various log removal credits. Water treatment systems like Carlton's are required to compare the CT required from the tables to the CT provided on a daily basis to ensure compliance with the SWTR.

The EPA also has published tables of CT required to provide 4-log removal of viruses. The CT times for 4-log virus removal are all shorter than the CT times for the 1-log removal of *Giardia lamblia.* Therefore, as long as the City operates the disinfection system to provide 1-log inactivation of *Giardia lamblia,* the 4-log virus removal requirement will also be met.

For systems like Carlton's the SWTR also required that effluent turbidity from the filters did not exceed 0.5 nephelometric turbidity unit (NTU) in 95% of the samples collected with no single result greater than 5 NTU. Stricter limitations for filter performance have been adopted as part of subsequent rules discussed below.

3.3.1.5 Long Term 1 Enhanced Surface Water Treatment Rule

The Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) was promulgated in 2002. This rule builds on the SWTR by providing improved public health protection against *Cryptosporidium*, while addressing risk tradeoffs with disinfection by-products. The LT1ESWTR applies to systems like Carlton's that use surface water. Specific provisions of the LT1ESWTR include the following.

- Maximum contaminant level goal (MCLG) of zero for *Cryptosporidium*
- 2-log (99%) *Cryptosporidium* removal requirement for systems that filter
- Strengthened combined filter effluent turbidity performance standards for systems using conventional and direct filtration
- Individual filter turbidity monitoring provisions for systems using conventional and direct filtration

Treatment plants such as Carlton's that use direct filtration (consisting of coagulation and filtration) are assumed to meet the 99% *Cryptosporidium* removal requirement as long as they comply with the LT1ESWTR turbidity requirements and existing provisions of the Surface Water Treatment Rule. A system's combined filter effluent turbidity is required to be less than 0.3 NTU in at least 95% of the samples collected with no single result greater than 1 NTU in order to provide the required 2-log removal of *Cryptosporidium.* For the month of June 2010 the City was unable to maintain 95% of turbidity samples under 0.3 NTU. The City has since been able to meet the filter effluent turbidity requirement necessary to provide 2-log inactivation of *Cryptosporidium*.

3.3.1.6 Long Term 2 Enhanced Surface Water Treatment Rule

The Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) builds on the provisions of the LT1ESWTR for further protection of public health against risks posed by *Cryptosporidium* and other microbial pathogens. The LT2ESWTR applies to all public water systems that use surface water and GWUDI. The goal of the LT2ESWTR is to identify high risk systems and require additional treatment to remove *Cryptosporidium* in those systems. Existing drinking water regulations established in the LT1ESWTR require water systems such as Carlton's to provide at least 2-log removal of *Cryptosporidium*. New data on *Cryptosporidium* infectivity, occurrence, and treatment indicate that the current treatment requirements are adequate for the majority of systems. However, there is a subset of systems with higher vulnerability to *Cryptosporidium* where additional treatment is necessary.

All water systems that utilize surface water or GWUDI are required to monitor the source water for *Cryptosporidium*. These water systems will be classified into one of four risk bins based on the results of the source water monitoring. The LT2ESWTR specifies a range of treatment and management strategies, collectively termed the "microbial toolbox," that systems can select from to meet any additional treatment requirements that are required as a result of their bin classification.

To reduce monitoring costs, small filtered water systems like Carlton's are first required to monitor for *E. coli*–a bacterium that is less expensive to analyze than *Cryptosporidium*. These small water systems are required to monitor for *Cryptosporidium* only if their *E. coli* results exceed specified concentration levels.

The City of Carlton conducted the initial round of *E. Coli* testing in 2008 &2009. As a result of initial testing the water system was assigned a Bin 1 classification on November 18, 2009. Bin 1 classification indicates that the initial testing concentrations were less than the trigger level of 100 *E. coli*/100 mL specified for flowing stream sources in addition to the system serving less than 10,000 people. This meant that Carlton did not need to monitor the source water for *Cryptosporidium*. As a result of being assigned to the Bin 1 classification, Carlton is not considered a high risk system for *Cryptosporidium* and no additional treatment or management strategies are required.

While the initial round of testing went well for Carlton, the LT2ESWTR requires a second round of *E. Coli* monitoring for the City's source water. This second round of tests must be completed prior to October 2017 and could result in the City being assigned to a higher risk bin triggering the potential for additional treatment requirements at the water treatment plant.

3.3.1.7 Microbial Contaminant Regulation Summary

Table 3-1 provides a summary of the current regulatory requirements as discussed above.

Table 3-1 Summary of Current Microbial Contaminant Regulations

Regulation	Current Regulatory Impact
Total Coliform Rule (TCR)	• Two samples required per month and sample results reported to the State • No coliform detection in the samples • Repeat sampling if coliform bacteria detected • Consumer notification required if sampling does not occur or if fecal coliform or E. coli are detected in repeat sampling
Revised Total Coliform Rule (RTCR)	• Continue to follow the TCR until April 1, 2016 • Total coliform no longer a basis for consumer notification • Total coliform above a threshold triggers assessment and correction of water system deficiencies • E. coli present requires consumer notification as well as assessment and correction of water system deficiencies
Surface Water Treatment Rule (SWTR)	• Provide disinfection before discharging into the distributions system • Provide filtration • Achieve 3-log (99.9%) removal and/or inactivation of *Giardia lamblia* • Achieve 4-log (99.99%) removal and/or inactivation of viruses • SWTR turbidity standards replaced by LT1ESWTR • Minimum disinfectant residual of 0.2 mg/L at the entry point to the distribution system • Maintain minimum detectable levels of disinfectant at all locations in the distribution system
Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR)	• MCLG of zero for *Cryptosporidium* • 2-log (99%) *Cryptosporidium* removal requirement • Combined Filter Effluent (CFE) turbidity must be less than 0.3 NTU in at least 95% of samples and no single sample greater than 1 NTU • Continuous Individual Filter Effluent (IFE) monitoring. Follow-up actions required if IFE turbidity exceeds 1.0 NTU in 2 consecutive readings or more.
Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)	• Currently no additional treatment required • Round 2 E. Coli testing must be completed by October 2017 • Additional treatment requirements not expected based on Round 1 testing.

3.3.2 Disinfectants and Disinfection Byproducts Rule

Disinfection of drinking water can readily be identified as one of the major public health advances of the 20th century. While disinfectants are effective in controlling many microorganisms, they react with natural organic and inorganic matter in water to form disinfection byproducts (DBPs) which have been shown to be carcinogenic in laboratory animals. While it is important to strengthen protection against microbial contaminants, it is also important to reduce the potential health risks of DBPs.

The Federal Total Trihalomethane Rule was published in the Federal Register in November 1979 and established a MCL for total trihalomethanes (TTHMs) for community water systems serving 10,000 people or more. The Stage 1 Disinfectants and Disinfection Byproducts Rule (Stage 1 DBPR) promulgated in December of 1998 built on the TTHM Rule by lowering the existing MCL and widening the range of affected systems to include all public water systems that add a disinfectant to their drinking water. The rule specifically established:

- a maximum residual disinfectant level goal (MRDLG) for chlorine at 4.0 mg/L
- a maximum residual disinfectant level (MRDL) of 4.0 mg/L for chlorine
- a total trihalomethane MCL of 80 µg/L, regulating the sum of four trihalomethanes
- a haloacetic acid (HAA5) MCL of 40 µg/L, regulating the sum of five haloacetic acids

The rule also established removal limits of total organic carbon (TOC) as a DBP precursor.

The Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) was finalized on January 4, 2006 and applies to water systems that use groundwater, GWUDI, and surface water. The rule retains the MCLs for TTHMs and HAA5s established in the Stage 1 DBPR and augments the rule by providing more consistent protection from DBPs across the entire distribution system and by focusing on the reduction of DBP peaks.

The Stage 2 DBPR requires community water systems to conduct initial distribution system evaluations (IDSEs) to identify and select new compliance monitoring sites that more accurately reflect sites representing high TTHM and HAA5 levels. These new ‘worst-case’ monitoring sites are selected based on the results of the Stage 1 DBPR compliance monitoring. The rule also redefines the method of calculating MCLs. Compliance with each MCL will be based on a locational running annual average (LRAA) instead of the running annual average (RAA) method used under the Stage 1 DBPR.

3.3.2.1 DBPR Regulatory Monitoring

Community water systems can fulfill the IDSE requirements by applying for 40/30 Certification, a process whereby a community water system certifies that all individual TTHM and HAA5 monitoring results for compliance with the Stage 1 DBPR are less than or equal to 40 µg/L for TTHM and 30 µg/L for HAA5 during a prescribed 2-year period. In addition the system must not have had any Stage 1 DBPR monitoring violations for TTHM and HAA5 during the same period. At the state’s discretion, a system meeting all of the requirements for 40/30 certification may still be required to conduct standard monitoring. Systems that qualify for reduced monitoring may remain on reduced monitoring as long as their quarterly LRAAs for TTHMS and HAA5 remain no more than 40 µg/L and 30 µg/L, respectively (for systems with quarterly reduced monitoring) or their TTHM and HAA5 samples are no higher than 60 µg/L and 45µg/L, respectively (for systems with annual or less frequent monitoring).

3.3.2.2 DBPR Municipal Compliance

TTHM and HAA5 data reported to ODWP (now ODWS) for 2002 through 2012 have been less than the respective MCLs. The City submitted samples in January of 2011 which were not taken at the approved location (Main and Hendricks). Apart from this the City has been in compliance. At the present time, there is no indication that the City will have problems complying with the current MCLs.

3.3.3 Lead and Copper Rule

Lead or copper in Oregon tap water is primarily due to corrosion of plumbing system components within buildings. Consumers commonly describe the presence of copper as metallic, bitter or rusty. The ability to detect copper in tap water is thought to be controlled by individual sensitivity; however, water chemistry also plays a part since the flavor of copper is more noticeable at lower pH levels.

The control of lead and copper concentrations in drinking water began with the Oregon lead solder ban of 1985, which prohibited the use of lead pipe and set lead content limits for plumbing solder and brass fixtures. In 1991 the EPA promulgated the Lead and Copper Rule (LCR) to further regulate lead and copper concentrations in drinking water. The LCR was uniformly adopted by Oregon on December 7, 1992 and applies to community and non-transient, non-community public water systems. The rule is unique in that compliance is measured by water sampled from the consumer's tap instead of from sampling points at the water treatment plant or within the public distribution system. Failure to meet the regulatory limits requires the water utility to implement a corrosion control treatment process designed to reduce the corrosivity of the water.

3.3.3.1 LCR Regulatory Monitoring

The LCR establishes action levels of 15 µg/L for lead and 1.3 mg/L for copper. It also sets a secondary maximum contaminate level (SMCL) for copper at 1 mg/L. The LCR stipulates that sampling be conducted at "high-risk" homes, further defined as homes constructed prior to 1985 that utilize copper piping and lead-based solder. One-liter samples of standing water (first draw after a minimum 6-hours of non-use) are collected from homes identified in the water system sampling plan. In each round of sampling 90% of the samples must have lead levels less than or equal to the action level. The number of samples is determined by the municipal population and equated to 20 initial samples for the City's system. For initial samples collected from January through March of 1995, copper concentrations exceeded the action level requiring the City to collect additional samples in July of 1995. These additional samples were below the action levels for both lead and copper. The City then performed two rounds of required sampling collected at six-month intervals (2000 & 2001). Compliance was demonstrated with the semiannual sample sets collected in 2000 & 2001. Therefore, the sampling frequency was reduced to once every three years (with the reduced sample set of 10).

Water systems that cannot meet the action levels must install corrosion control treatment, and submit water sampling data to ODWS at proscribed frequencies. In the event the lead action level cannot be met with these measures in place a public education program, adjustments to the corrosion control program and follow-up sampling is required.

3.3.3.2 LCR Municipal Compliance

The initial monitoring results from 1995 show copper concentrations were above the action level. Since then monitoring results from July of 1995 to 2011 show the system to be in compliance for both lead and copper. Based on the City's successful compliance with corrosion control requirements, the sampling frequency required by ODWS is every three years.

3.3.4 Inorganic Contaminants

The USEPA regulates most chemical contaminants (inorganic and organic contaminants) through the rules known as Phase I, II, IIb, and V. The agency has issued the four rules over a five-year period after gathering, updating, and analyzing information on each contaminant's presence in drinking water supplies and its health effects.

Inorganic contaminants (IOCs) most commonly originate in the source of water supply, but can also enter the water from contact with materials used for pipes, plumbing fixtures and storage tanks. For most IOCs adverse health effects result after long-term (lifetime) exposure to the compounds. Water systems in Oregon rarely violate maximum levels for inorganic contaminants from source waters, but these contaminants are routinely detected in drinking water systems at levels more than one-half the maximum level. The most commonly detected inorganics in Oregon drinking water systems are nitrate, arsenic, nitrite, cadmium, and mercury.

The Oregon Drinking Water Act currently regulates 16 inorganic compounds (Antimony, Arsenic, Asbestos, Barium, Beryllium, Cadmium, Chromium, Cyanide, Fluoride, Mercury, Nickel, Nitrate, Nitrite, Selenium, Sodium and Thallium). Oregon law recognizes the acute health effects of nitrate, particularly for young children, and accordingly requires more stringent testing for nitrate. As previously noted a full listing of the inorganic MCL's appear in **Appendix A** at the end of this report.

3.3.4.1 IOC Regulatory Monitoring

Monitoring for IOCs is conventionally required once every three years and yearly for Nitrate. The City has qualified for a 9-year reduced monitoring cycle for IOCs with the exception of nitrate which is required annually.

3.3.4.2 IOC Municipal Compliance

In recent years the City has been in compliance with the IOC regulations. In 1987, Cadmium concentrations were equal to the MCL. Since 1987, the Cadmium concentrations in all samples have all been below detection limits. Based on the City's recent compliance history, the sampling frequency required by OWRD will likely remain once every nine years and no future compliance problems are anticipated.

3.3.5 Organic Contaminants

Current drinking water standards regulate a total of 56 organic contaminants frequently classified into two sub-groups, Volatile Organic Chemicals (VOCs) and Synthetic Organic Chemicals (SOCs). Organic contaminants are man-made chemicals and commonly include industrial and commercial solvents and chemicals as well as herbicides and pesticides used in agriculture and landscaping. A full list of the contaminants appears in **Appendix A.**

3.3.5.1 OC Regulatory Monitoring

Public water systems are required to test for each contaminant from each water source during every 3-year compliance period. Public water systems with a population greater than 3,300 must test twice during each three-year compliance period for SOCs (this is not expected to apply to Carlton in the planning period). Public water systems using surface water or GWUDI must test for VOCs at the entry point annually. Quarterly follow up testing is required for any contaminants that are detected. The exceptions are dioxin and acrylamide/epichlorohydrin. Only those systems determined by ODWS to be at risk of contamination must monitor for dioxin. Sampling may be reduced to a 6-year cycle if the system has a certified Drinking Water Protection Plan. Systems that cannot meet the MCLs must install or modify treatment systems or develop alternate sources.

3.3.5.2 OC Municipal Compliance

The last ± 20 years of SOC and VOC data was reviewed for this study. In 1987 Toxaphene concentrations exceeded the MCL. No other SOC or VOC data has exceeded the MCL. Since 1987 all SOC and VOC test results have been in compliance and recent results predict that the City will be able to comply with this rule in the future.

3.3.6 Radiologic Contaminants

The purpose of this rule is to limit exposure to radioactive contaminants in drinking water. Most drinking water sources have very low levels of radioactive contaminants, most of which are naturally occurring as trace elements in rocks and soils. Most radioactive contaminants are at levels that are low enough to not be considered a public health concern. At higher levels, long-term exposure to radionuclides in drinking water may cause cancer. Radon, another decay product of radioactive material, is regulated independently under the Radon Rule later in this chapter.

3.3.6.1 Radiologic Contaminants Regulatory Monitoring

Initial testing required by this rule began in 2005 and required all public water systems to test each source quarterly for one year, with test results required for gross alpha, radium-226/228 and uranium. Currently, test frequency has been reduced to every 9 years for gross alpha, radium-226/228 and uranium, and radium-uranium. Testing is required to resume on a quarterly basis if the MCL is exceeded.

3.3.6.2 Radiologic Contaminants Municipal Compliance

All radiologic test results have been in compliance. Historic results suggest that the City will be able to comply with this rule in the future.

3.3.7 Arsenic Rule

On January 22, 2001 EPA adopted a new standard for arsenic in drinking water at 10 micrograms per liter (µg/L or ppb), replacing the old standard of 50 µg/L. Oregon adopted the rule and the new limit went into effect on October 21, 2004.

Arsenic is a naturally occurring chemical found in the earth’s crust, but can be dangerous to humans when released into drinking water supplies as rocks, minerals, and soils erode. Studies have linked long-term exposure to arsenic contamination with cancer and cardiovascular, pulmonary, immunological, neurological, and endocrine effects.

3.3.7.1 Arsenic Rule Regulatory Monitoring

Systems with surface water sources must sample annually whereas systems with groundwater sources sample every three years. Water systems that exceed the MCL must monitor quarterly and meet the MCL as a running annual average. Public water systems that cannot meet the MCL must either install water treatment systems or develop alternate sources of water.

3.3.7.2 Arsenic Rule Municipal Compliance

To date, the arsenic MCL has only been exceeded once in 1986. Since this time the City has not detected any arsenic in any of the samples collected and has therefore been in compliance. Results since 1986 indicate that the City will be able to comply with this rule in the future.

3.3.8 Secondary Contaminants

The EPA has established National Secondary Drinking Water Regulations that set non-mandatory secondary maximum contaminant level (SMCL) water quality standards for 15 contaminants. The EPA does not enforce these SMCLs as they are not considered to present a risk to human health at the listed levels. They are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations. **Table 3-2** presents these contaminants.

Table 3-2 Secondary Maximum Contaminant Levels

Contaminant	Secondary MCL	Noticeable Effects above the Secondary SMCL
Aluminum	0.05 – 2.0 mg/L	Colored water
Chloride	250 mg/L	Salty taste
Color	15 color units	Visible tint
Copper	1.0 mg/L	Metallic taste, blue-green staining
Corrosivity	Non-corrosive	Metallic taste, corroded pipes/fixture staining
Fluoride	2.0 mg/L	Tooth discoloration
Foaming Agents	0.5 mg/L	Frothy, cloudy, bitter taste, odor
Iron	0.3 mg/L	Rusty color; sediment, metallic taste, reddish or orange staining
Manganese	0.05 mg/L	Black to brown color, black staining, bitter metallic taste
Odor	3 TON (1)	Musty, “rotten-egg” or chemical smell
pH	6.5 – 8.5	Low pH: bitter metallic taste, corrosion High pH: slippery feel, soda taste, deposits
Silver	0.1 mg/L	Skin discoloration, graying of the white part of the eye
Sulfate	250 mg/L	Salty taste
Total Dissolved Solids	500 mg/L	Hardness, deposits, colored water, staining, salty taste
Zinc	5 mg/L	Metallic taste

[1] Threshold Odor Number

3.3.8.1 Regulatory Monitoring

Secondary maximum contaminant levels are non-mandatory regulations and therefore do not have a monitoring requirement.

3.3.9 Filter Backwash Recycling Rule

The Filter Backwash Recycling Rule (FBRR) was published in the Federal Register on April 10, 2000 and was adopted by the State of Oregon in June of 2004. The FBRR complements existing surface water and GWUDI treatment rules by reducing the potential for microbial pathogens, particularly *Cryptosporidium* oocysts, to pass through the filters into the finished water. The FBRR requires all recycled waste streams (e.g., spent filter backwash, thickener supernatant, or liquids from dewatering processes) to be returned to the head of the plant and passed through the entire treatment process, unless properly disposed of otherwise.

3.3.9.1 Municipal Compliance

The City does not currently recycle backwash water through the plant. As such, the City's plant is in compliance with the filter backwash rule.

3.4 CONSUMER CONFIDENCE REPORT RULE

The EPA published the Consumer Confidence Report (CCR) Rule in the Federal Register on August 19, 1998. The CCR Rule requires community water systems to provide an annual report to their customers detailing information on water quality delivered by the system and documenting water quality monitoring results.

The report must be distributed by July 1 of each year, must contain an explanation of data collected during or prior to the previous calendar year, and must provide the telephone number of the owner, operator or designee of the community water system as a source of additional information concerning the report. This information is typically sent out with water bills; however, systems must make a good faith effort to reach consumers who do not get water bills (typically renters). Water systems must certify to ODWS that the CCR was sent to customers and that the information it contained was correct and consistent with the compliance monitoring data previously submitted to ODWS. Complete details of the rule requirements can be found in OAR 333-061-0043.

3.5 CROSS-CONNECTION CONTROL PROGRAM

Plumbing cross-connections, defined as actual or potential connections between a potable and non-potable water supply, constitute a serious health hazard. There are numerous well documented cases where cross-connections have been responsible for the contamination of drinking water and have resulted in poisonings or the spread of disease.

Oregon Administrative Rules 333-061-0070 through 0074 detail the requirements for a cross-connection control program. The City is required to establish a cross-connection ordinance and must submit an annual report to ODWS. Systems with more than 300 service connections are required to provide a certified tester.

The City's cross-connection control standards are contained in Chapter 13.16 of the Carlton Municipal Code. The City currently employs one certified cross connection control specialist who is responsible for inspecting new devices and installations, monitoring annual inspections, terminating water service in cases of non-compliance and submitting the annual inspection report to ODWS.

3.6 WATER SYSTEM SURVEY

ODWS conducts a Water System Survey (formerly called a Sanitary Survey) of each public water system on a regular basis. Water System Surveys are a critical component of the State's drinking water regulatory program. Under Oregon statute, a Water System Survey is "*an on-site review of the source, facilities, equipment, operation and maintenance of a water system, including related land uses, for the purpose of evaluating the capability of that water system to produce and distribute safe drinking water*."

The Water System Survey (conducted by ODWS or contract County health department staff) results in a report that includes, as a minimum, "*the following components of a water system: source of supply; treatment; distribution system; finished water storage; pumps, pump facilities and controls; monitoring, reporting and data verification; system management and operations; and operator certification compliance*." The Water System Survey report identifies any significant deficiency prescribed in OAR 333-061-0076, or any violation of drinking water regulations, discovered during the on-site visit.

Public water systems must have completed corrective action of any significant deficiencies within 120 days of receiving written notice, or be in compliance with an ODWS approved "corrective action plan" within 120 days of receiving written notice of a significant deficiency.

The most recent Water System Survey for Carlton was conducted on July 9, 2013 with the associated report issued by the Drinking Water Program on July 15, 2013. A copy of the report is included as **Appendix B** to this report.

3.7 FUTURE WATER QUALITY REGULATIONS

The following include both existing regulations which may not apply to the City at present, but which it may become subject to in the future, as well as anticipated future rules that are currently in the regulatory pipeline.

The EPA is required to review existing national primary drinking water regulations every six years in order to identify current health risk assessments, changes in technology, and other factors that provide a health or technological basis to support regulatory revisions to maintain or improve public health protection.

3.7.1 Vulnerability Assessment

This is an existing regulation that the City may become subject to in the future. The events of Sept. 11, 2001, reinforced the need to enhance the security of the United States. Congress responded by passing the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (the Bioterrorism Act), which was signed into law June 12, 2002. The Act amends the Safe Drinking Water Act, requiring every community water system that serves a population greater than 3,300 persons to conduct a vulnerability assessment, and specifies actions that community water systems and the USEPA must take to improve the security of the nation's drinking water infrastructure.

Complete details of the requirements for Oregon water systems can be found in OAR 333-061-0064. The City should be prepared to complete this vulnerability assessment when they reach the regulatory population threshold. The City should review its vulnerability assessment periodically to account for changing threats or additions to the system to ensure that security objectives are being met.

3.7.2 Unregulated Contaminant Monitoring Rule

This is an existing regulation that the City may become subject to in the future, if the population limits in the rule are modified, or if ODWS decides to include the City in this program. The Unregulated Contaminant Monitoring Rule (UCMR) is used to collect data for contaminants suspected to be present in drinking water, but that do not have health-based standards set under the Safe Drinking Water Act. The UCMR is closely coordinated with EPA's Contaminant Candidate List. The EPA uses both of these programs to identify drinking water contaminants that are not currently regulated in order to identify future health risks and problems with drinking water.

To date, the program has been implemented in three stages, UCM Rounds 1 & 2, UCMR1 and UCMR2 on a 5-year cycle. The first stage was managed by the state primacy agencies and consisted of screening and assessment monitoring tests. The UCMR1 promulgated on September 17, 1999 utilized a tiered monitoring approach that required all large public water systems and a nationally representative sample of small public water systems serving less than 10,000 people to monitor for selected sets of contaminants. The UCMR2 promulgated on January 4, 2007, is being managed by the EPA and requires monitoring for a new set of unregulated contaminants. To date, the City has not been required to collect data for the UCMR, but may be required to in the future.

3.7.3 Radon

This is an anticipated new regulation. Radon is a naturally occurring gas formed from the decay of uranium-238. Radon in drinking water can contribute to indoor air radon levels from washing and showering. Inhalation or ingestion of radon can result in lung or stomach cancer. The USEPA has proposed preliminary guidelines for the regulation of radon; however, the final form of the rule has yet to be promulgated.

We are not aware of radon testing performed to date on any of the City source water. Since the City's primary water source is surface water and radon readily volatilized from turbulent waters, it is very unlikely that radon exists in the City's water system.

3.8 CITY PUBLIC WORKS DESIGN STANDARDS

The City presently has detailed design criteria for water system improvements under City jurisdiction. These Public Works Design Standards (PWDS) provide a uniform set of standards for use by engineers in the design of public water distribution improvements. The intent of these standards is to provide guidelines for the design of public facilities that will provide an adequate service level for the present development as well as for future development. The PWDS cannot provide for all situations. They are intended to assist but not to substitute for competent work by design professionals.

The intent of the PWDS is to:

- be consistent with current City Ordinances.
- provide design guidance criteria to the private sector for the design of public improvements within the City of Carlton.
- have sufficient structural strength to withstand all external loads that may be imposed;

- be of materials resistant to both corrosion and erosion with a minimum design life of 75 years;
- be economical and safe to build and maintain;
- meet all design requirements of Oregon Drinking Water Services (ODWS).

3.9 WATER USE REGULATIONS (WATER RIGHTS)

The Oregon Water Resources Department (OWRD) regulates the use of both surface and groundwater throughout the state of Oregon. On February 24, 1909, the State of Oregon enacted the Water Rights Act, a comprehensive surface water code. This act made “prior appropriation” the sole method of acquiring water rights in Oregon. The system is basically one of first come, first served. Each water right includes a priority date. Prior appropriation utilizes the priority date of a water right to establish the order in which water rights are satisfied in times of shortage. A senior water right is entitled to full delivery of all water under their right before any junior rights are served. Oregon adopted a groundwater code on August 3, 1955. Together, these codes establish a regulatory scheme under which the OWRD exercises jurisdiction over the right to use the State’s waters.

In Oregon, all water is publicly owned. With some exceptions, the use of this public water requires a permit from OWRD. Water rights are issued only for beneficial use, without waste. Each water right includes a designated type of “use” and is limited to that purpose. General categories of beneficial use include, but are not limited to irrigation, municipal, industrial, commercial and domestic. Since 1987, the law has specifically included instream flow protection as a beneficial use. A water right holder is entitled to use of water up to the maximum rate and/or volume shown on the water right to accomplish the stated beneficial use.

Water rights are initially issued as water right *permits*, and upon demonstrating beneficial use a certificate is issued confirming the right. Holders of municipal use permits can “partially perfect” or partially certificate a water right. A water right permit serves as the initial authorization for a water user to develop the source and begin making beneficial use of the water. The permit typically describes the source, the source location, the priority date, the amount of water that can be used, and documents any water use conditions. Water right permits include a date by which the water right must be put to full beneficial use. If the water use is not fully developed within that timeframe, an extension of time to fully develop the permit could be requested. In evaluating extension requests, the OWRD considers whether or not the applicant has shown diligence in the development of the water right.

Beginning in the late 1990’s OWRD began to make substantial l changes to the permit extension process. In 2002 the OWRD adopted new rules governing extensions of municipal use permits. The new rules require a more extensive analysis of the level of diligence shown by the permit holder in developing the water right. Since 2005 the process also includes a careful review of potential impacts on listed species. . If a permit extension is approved, new conditions may be added to address public interest concerns raised during the review process.

In 2005, House Bill 3038 was passed by the Oregon legislature. The Bill gives municipal water developers an initial 20 years to develop their water rights. . Development of the water rights must proceed with a reasonable level of diligence. However, OWRD may order or allow an extension of time to complete construction or to perfect a water right beyond the time specified in the permit under the following conditions.

- If the holder shows good cause and if other governmental requirements relating to the project have significantly delayed completion of construction or perfection of a water right;
- The extension of time is conditioned to provide that the municipality may divert water beyond the maximum rate diverted for beneficial use before the extension only upon approval by OWRD of a water management and conservation plan; and
- For permits issued prior to November 2, 1998, the first extension issued after the effective date of the Bill , the undeveloped portions of the permit is required to maintain the fish listed as sensitive, threatened or endangered, within the waterway affected by the permit.

A water right certificate is issued after the source is partially perfected or fully developed and put to use. At such time, the permit holder submits a Claim of Beneficial Use (COBU) to the OWRD. Approval of the COBU results in the issuance of a water right certificate. Once issued, the certificate serves as evidence of a fully vested water right. At this stage the water right is treated as a property right held by the water user. Certificated right remains valid indefinitely unless it is unused for a period of five or more years, in which case the user may forfeit the water right. The forfeiture process is not automatic. Oregon law has historically protected municipal water supplies by preventing forfeiture for non-use.

3.10 WATER MANAGEMENT AND CONSERVATION PLAN

In addition to regulating water rights, the OWRD has regulatory authority over Water Management and Conservation Plans (WMCP) for public water systems. A WMCP is a plan developed by a water supplier that describes the water system and its needs, identifies its sources of water, describes water curtailment policies, and explains how the water supplier will manage and conserve those supplies to meet present and future needs. The requirement for completing such plans is tied to the revised rules surrounding water right permit extensions as described under OAR 690-315. OAR 690-086 details the requirements of WMCPs. Carlton is currently preparing a new WMCP that is being completed in conjunction with this Water System Master Plan and in anticipation of having completed permit extensions.

CHAPTER 4

EXISTING WATER SYSTEM

Chapter Outline

EXISTING WATER SYSTEM

4.1 INTRODUCTION

The City of Carlton operates and maintains the water system that provides potable water service to customers within the city limits plus a variety of customers outside the City Limits including individual customers, the Valley View Water District and the East Carlton Water Company. The City system is classified as a “community” water system and has been assigned Public Water System (PWS) Identification Number OR41-00171.

This chapter provides an inventory of the existing water system components (sources of supply, water treatment, distribution system, storage reservoirs, and instrumentation and control). The evaluation of these specific systems and the development of improvement alternatives are contained in other chapters of this study.

4.2 WATER SYSTEM OVERVIEW

In 1911 the City of Carlton applied for water rights on Panther Creek. That application included the intent to construct a 30 foot long, 3 foot high concrete dam across Panther Creek just downstream of the current reservoir dam and a 9 mile long pipeline into town. These water rights for 0.50 CFS were certified in 1917.

The original application does not appear to include the City’s 380,000 gallon concrete finished water storage reservoir on Meadow Lake Road. The actual date of construction for the concrete reservoir is unknown, but believed to date to the early 1900s.

In 1960 the City commissioned a study for a larger dam on Panther Creek. Following this the City applied for additional Panther Creek water rights in 1967 and 1969. The 1967 application was founded on the City’s plan to increase the size of the transmission main. The 1969 applications provided for storage behind the proposed larger dam as well as additional water use. The current Carlton Reservoir dam was constructed in 1970. Additional water rights applications related to use of water from Panther Creek and storage in Carlton Reservoir were submitted in 1987 based on modifications to the reservoir dam to increase the storage area. A more detailed discussion of these water rights is provided in Chapter 4 of this report.

By 1936 the City’s map atlas shows the City had a well developed distribution system covering the entire community at that time. Various water system maps of different age’s document the growth and change of the distribution system as the town grew and also as older lines were replaced.

Records for the early development of water treatment for the Carlton are not available. The 1984 construction drawings for a water treatment plant on the site of the current treatment plant near the intersection of Panther Creek Road and the Carlton Reservoir access road show a chlorination system as existing at that time. According to 1996 Water Master Plan the 1984/5 water treatment plant initially had a stated capacity of over 600 gpm (880,000 gpd). However, between 1985 and 1996 the Oregon Health Division evaluated this plant and reduced the rated capacity to just over 300 gpm (440,000 gpd). This plant was expanded in 2003 to provide a total capacity of 975 gpm (1.4 MGD).

The project that constructed the 2003 water treatment plant expansion also included a new 1 MG steel finished water reservoir (nominal size, actual capacity 0.987 MG to overflow) south of Meadow Lake Road approximately 1/4 mile closer to town than the older concrete finished water reservoir, providing the City with a total storage capacity of 1.336 MG.

There are three other water system items to note that do not directly affect the current normal water system operations but need to be kept in mind while planning and evaluating future water system infrastructure. These are: (1) Fall Creek Water Right, (2) Yamhill Regional Water Authority (YRWA), and (3) Old Emergency Intertie with McMinnville.

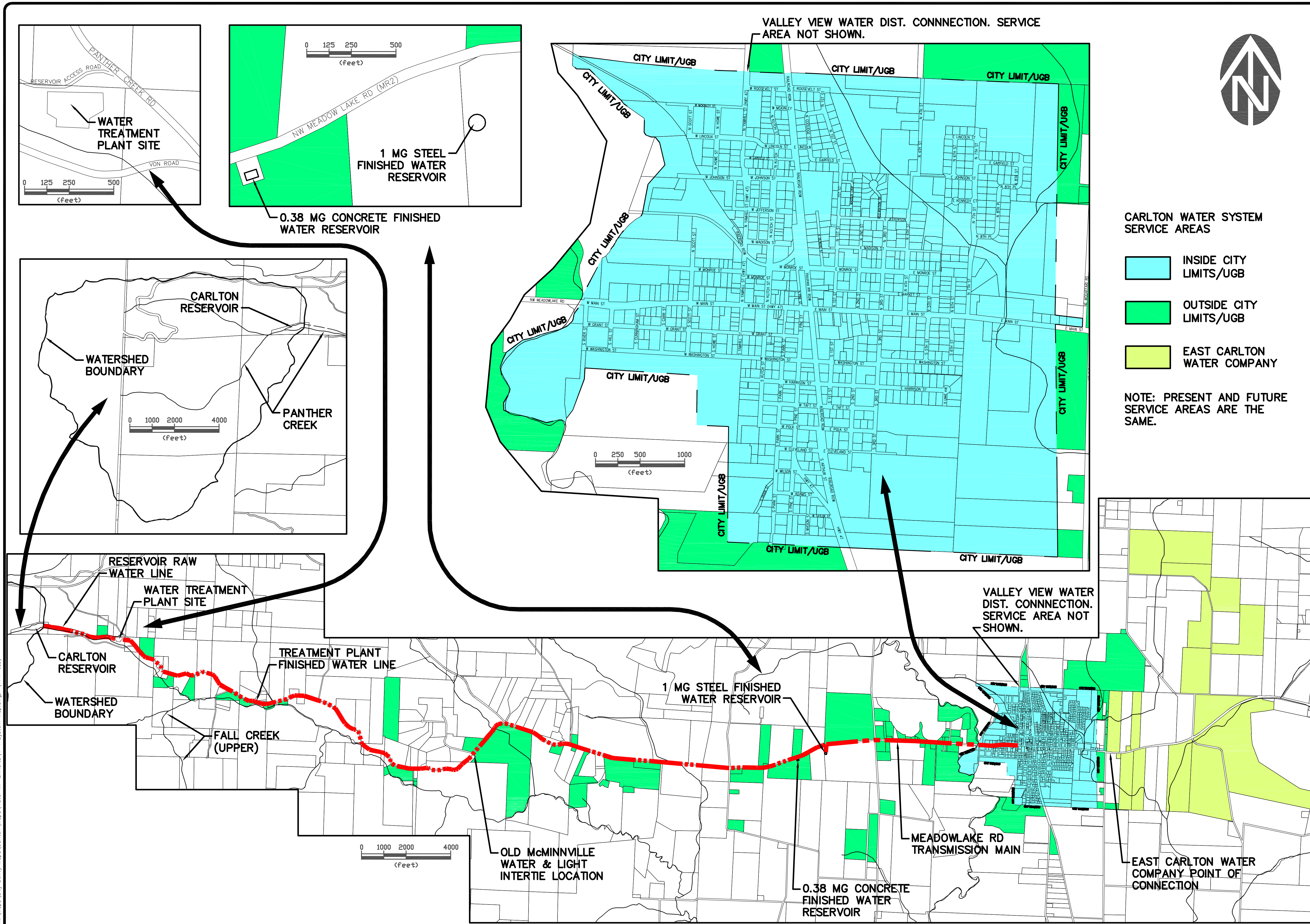
(1) Fall Creek. In 1967 the City applied for water rights from Fall Creek which joins Silver Creek near Von Reservoir, about 3/4 mile southeast (downstream) of the water treatment plant. The intent was to provide an alternate source of supply for periods when flows in Panther Creek were low, or when high turbidity in Panther Creek reduced the capacity of the water treatment system. The permit for these rights has been subject to several extensions and the current extension request is under review.

(2) YRWA. The cities of Carlton, McMinnville, Dayton and Lafayette have formed the Yamhill Regional Water Authority (YRWA). In January 2013 the YRWA was granted a permit for water rights on the Willamette River totaling 44.18 CFS, of which 2.98 CFS is intended to be allocated to the City of Carlton. Specific details related to planning for and construction of infrastructure which will allow the YRWA to remain to be developed.

(3) Intertie. The old emergency system intertie with the McMinnville Water & Light system is at the intersection of Panther Creek Road and Red Shot Lane. In this location a McMinnville W&L 16-inch transmission line running from Haskins Creek Reservoir to McMinnville crosses the City's transmission main. According to the 1996 Water Master Plan this connection was used in February 1996 when heavy flooding rendered the Carlton water treatment plant unusable. There is no known agreement governing the use of this connection and it is included here primarily for documentation purposes. Future use of this connection would require the development of an agreement between the City of Carlton and the City of McMinnville.

4.2.1 Water System Schematic & Maps

An overall Carlton Water System Map is provided as **Figure 4-1** and a schematic representation of the water system is presented in **Figure 4-2**. More detailed system maps are provided within the other sections of this study as applicable (i.e., distribution maps in Section 7). Full size water system maps are included in **Appendix C**.



NO. | DATE | DESCRIPTION | BY
REVISIONS

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

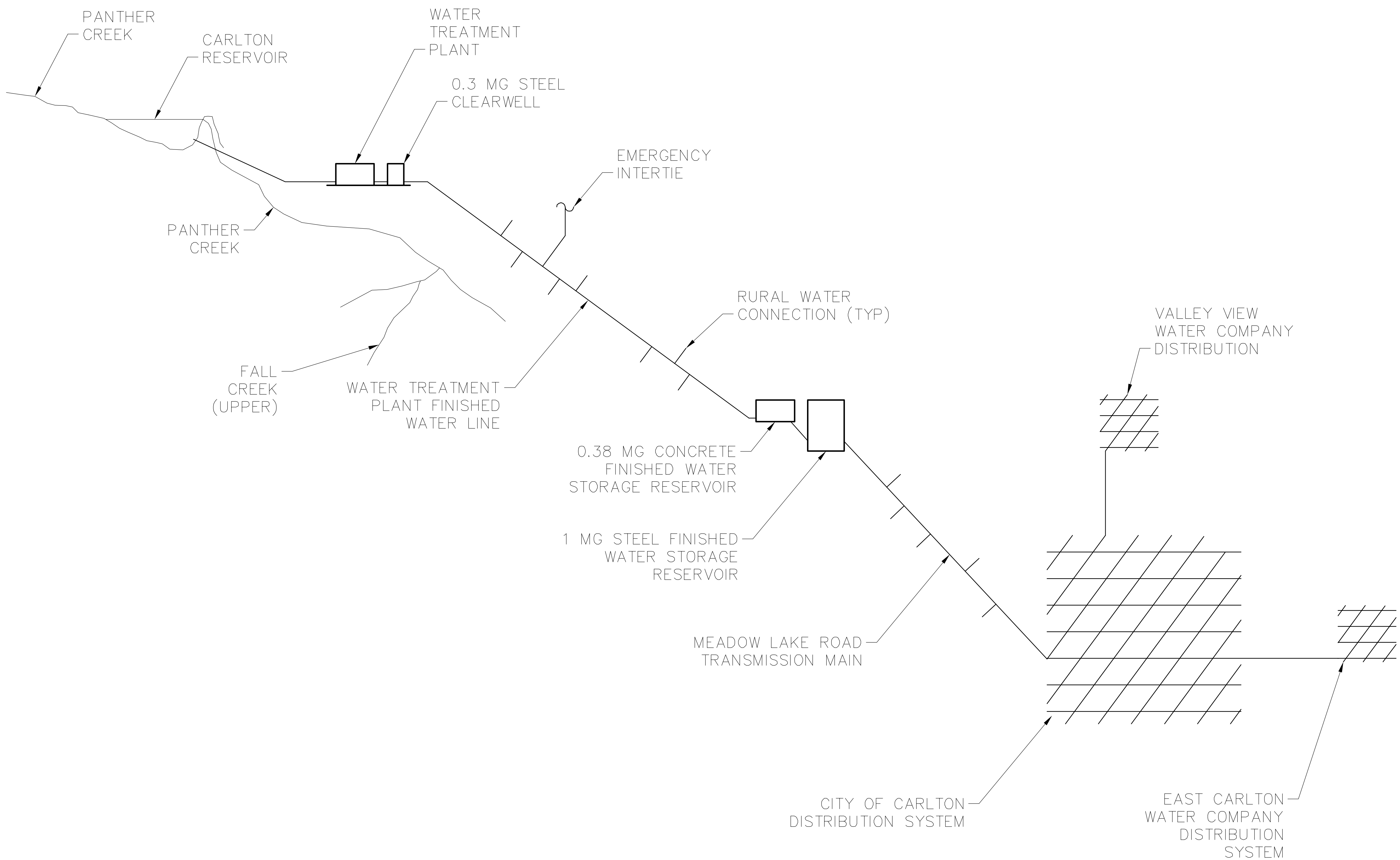
WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

City of Carlton, Oregon

OVERALL WATER SYSTEM MAP

FIGURE 4-1

JOB NUMBER 2674.0000.0



City of Carlton, Oregon

CITY OF CARLTON WATER SYSTEM SCHEMATIC

FIGURE 4–2

JOB NUMBER 2674.0000.0

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585–2474 Fax: (503) 585–3986
E–mail: westech@westech–eng.com

VERIFY SCALE
BAR IS ONE–HALF INCH ON ORIGINAL DRAWING
0 .5"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN.	RCE
DRN.	RCE
CKD.	RCE
DATE:	MAR 13

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

11/17/2014 12:36:21 PM
R:\Maps\City Utility Maps\Carlton\Maps\Water MP Exhibits\4–2 System Schematic.dwg, (1117 tab)

4.3 WATER SUPPLY

Carlton's primary water supply is the surface water from Panther Creek from storage in Carton Reservoir. While the City has several other potential sources of supply (Fall Creek, Willamette River with the Yamhill Regional Water Authority, McMinnville Intertie), for most if not all of the 20 year planning period covered by this study the Panther Creek/Carlton Reservoir source is anticipated to continue to be the City's sole source of supply under normal circumstances. Therefore the predominant focus with regard to water supply will be on the Panther Creek/Carlton Reservoir source, with limited attention given to other sources.

4.3.1 Current Water Rights

Table 4–1 is a summary of the current water rights held by the City of Carlton for which Certificates have been issues, listed by priority date (oldest to newest). **Table 4-1** is divided into two parts with Table **4-1a** showing rights to use the water while **Table 4-1b** shows rights for storing water in Carlton Reservoir. **Table 4-2** provides a summary for Carlton's water rights that have been permitted, but not certificated.

Table 4–1a Water Rights Summary/Certificated Rights/Water Use (listed by priority date)

Source Name[(1)]	Permit Rate CFS (gpm)	Volume[(1)] (AF)	Appl #	Perm #	Certificate #	Priority Date
Panther Creek	0.50 (224)	N/A	S-1609	S-914	1868	8-12-1911
Panther Creek & Carlton Reservoir	0.271[(2)] (103)	66	S-46505	S-34661	86064	10-22-1969
Panther Creek & Carlton Reservoir	0.018[(2)] (8)	9	S-69513	S-50218	86065	11-30-1987

(1) Water storage must be authorized in two parts. One part is the authority to store. The second part is the authority to use what was stored. This refers to the use of water that has been stored.
(2) These applications have been divided. This portion has been certificated. The corresponding items in Table 4-2 have been permitted but not certificated.

Table 4–1b Water Rights Summary/Certificated Rights/Water Storage (listed by priority date)

Source Name[(1)]	Volume[(1)] (AF)	Appl #	Perm #	Certificate #	Priority Date
Panther Creek for Carlton Reservoir	66	R-46504	R-5527	85744	10-22-1969
Panther Creek for Carlton Reservoir	9	S-69512	R-10900	85747	11-30-1987

(1) Water storage must be authorized in two parts. One part is the authority to store. The second part is the authority to use what was stored. This refers to the authority to store the water.

Table 4–2 Water Rights Summary/Water Use/Permitted Only, No Certificate (listed by priority date)

Source Name(1)	Permit Rate CFS (gpm)	Volume(1) (AF)	Appl #	Perm #	Certificate #	Priority Date
Panther Creek	2.50(2) (1,122)	N/A	S-44208	S-32489	N/A	10-27-1967
Fall Creek	2.00(3) (898)	N/A	S-44207	S-32488	N/A	10-27-1967
Panther Creek & Carlton Reservoir	0.229(4) (122)	N/A	S-46505	S-34661	N/A	10-22-1969
Panther Creek & Carlton Reservoir	0.052(4) (23)	N/A	S-69513	S-50218	N/A	11-30-1987
Willamette River	2.98(5) (1,338)	N/A	S-87762	S-54792	N/A	11-02-2011

(1) Water storage must be authorized in two parts. One part is the authority to store. The second part is the authority to use what was stored. This refers to the use of water that has been stored.
(2) An extension application for this was proposed for approval by OWRD but subsequently protested.
(3) An extension application has been submitted and is under review by OWRD.
(4) These applications have been divided. This portion has only been permitted, but not certificated. The corresponding items in Table 4-1a have been certificated.
(5) This water right totals 44.18 CFS for the Yamhill Regional Water Authority, of which 2.98 is intended for Carlton

Based on the information provided in the tables above the City has sufficient water rights for its current needs, especially when considering both Permitted and Certificated Water Rights, both of which are valid, legal water rights. Water rights are addressed in more detail in Chapter 6.

4.3.2 Water Supply, Panther Creek/Carlton Reservoir

Carlton Reservoir is located nine miles west of Carlton on Panther Creek. When full the reservoir was designed to cover roughly 4 acres of ground and hold around 60 acre-feet of water. Heavy sediment volumes coming down Panther Creek in recent history have reduced the reservoir area and volume. Currently no accurate estimate is available of the volume lost due to sedimentation.

The Carlton Reservoir watershed is estimated to be somewhat over 2,000 acres extending predominantly to the west and southwest of the reservoir. This ground is almost exclusively forested with ownership divided between the timber industry and government. Overall this provides good conditions for safe, clean water. One concern is that it is believed that logging activity has contributed to the increased sediment load entering Carlton Reservoir. In addition to decreasing the reservoir volume the sediment load increases water treatment plant turbidity which can mean water production rates must be decreased to ensure adequate treatment occurs to meet water quality standards.

The other water quality issue related to the Panther Creek water source is the level of iron and manganese. It appears that the total iron and manganese load is relatively constant throughout the year. However, when low flows occur during the summer the dilution is decreased resulting in increased concentrations that need to be addressed in the treatment process.

The City does not currently monitor reservoir inflow, thus the flow in Panther Creek can only be roughly approximated from circumstantial information. Under most circumstances the reservoir maintains a relatively consistent water surface elevation throughout the dry season. Generally, no water goes over the spillway and even in the driest summers the water level only decreases by 1-2 feet from normal high water. This provides an indication that the flow in Panther Creek is roughly equal to the water being used by the City. In the highest two months of the year the water treatment plant has a total production averaging around 0.5 CFS. Noting that evaporation during that period is approximately 7-inches per month, a very rough estimate of stream flow would be 0.5 cfs, consistent with water diverted to the water treatment plant, with the decrease in the reservoir water surface being attributable to evaporation.

Developing a more accurate understanding of the flow in Panther Creek is important to the further administration of a number of the Panther Creek water rights. The Panther Creek water rights include 0.789 CFS of Certificated water rights plus 2.781 CFS of Permitted water rights that have not been certificated. All of the Permitted water rights have been extended and are under review for further extension, and under scrutiny by private organizations that monitor state water rights actions. This issue is addressed in more detail in Chapter 6 as well in the City's new Water Management and Conservation Plan.

4.4 WATER TREATMENT

Water treatment for the Carlton water system occurs at the Water Treatment Plant about 3/4 of a mile east of Carlton Reservoir at the intersection of Panther Creek Road and the reservoir access road. The Carlton Water Treatment Plant uses pre-treatment as required plus coagulation and filtration to remove particulates, soda ash for pH adjustment for corrosion control and chlorine for iron and manganese removal and for disinfection. **Figure 4-3** is a schematic diagram of the Carlton Water Treatment Plant.

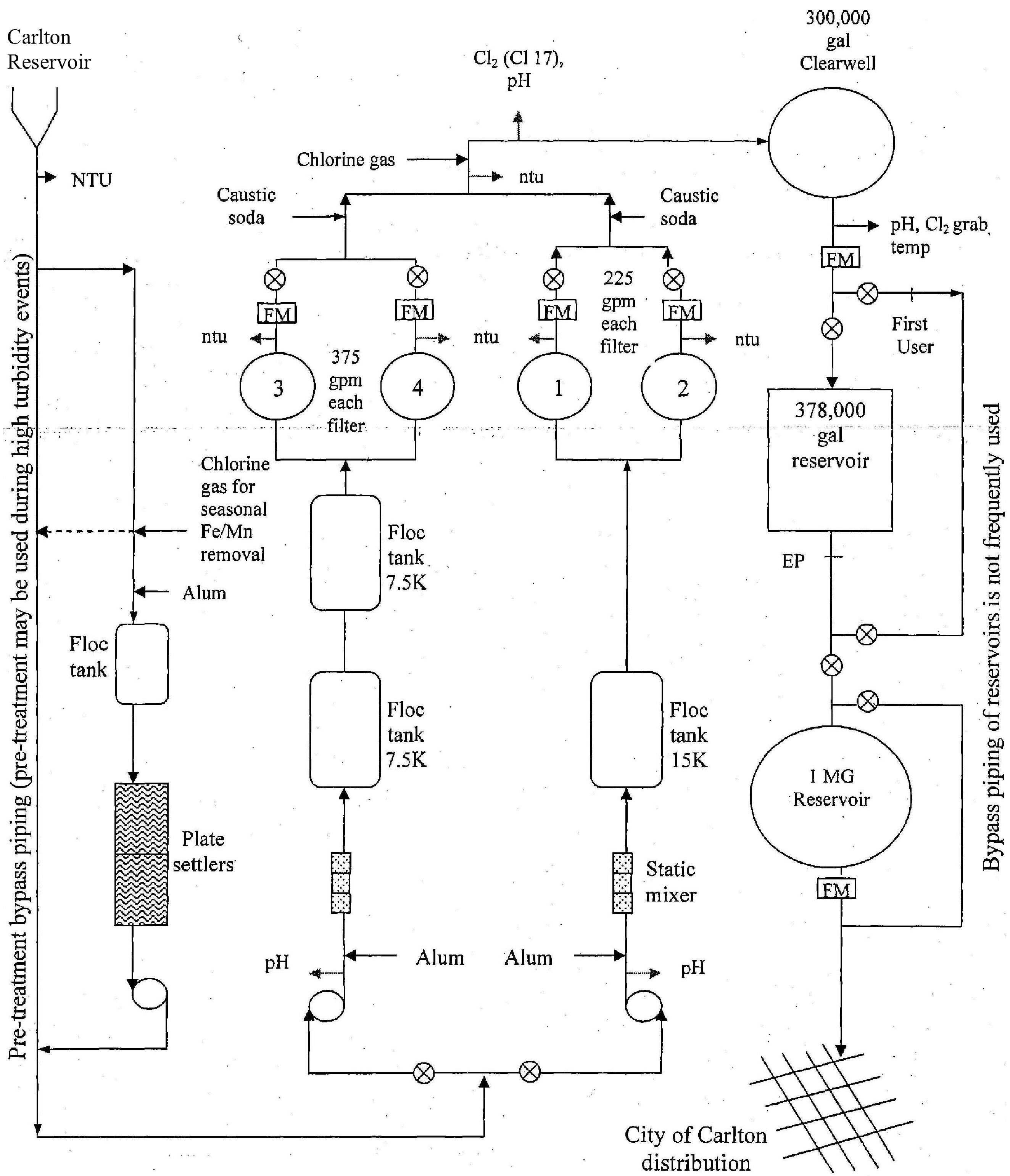
4.4.1 Sediment/Particulate Removal

4.4.1.1 Carlton Reservoir Floating Intake

The first component designed to remove sediment from the Carlton water system is a floating intake at the Carlton Reservoir. The original intake was at the bottom of the reservoir. Since sediment and particulates tend to sink their concentration at the bottom of the reservoir is typically higher than near the top. To address this, a pipe was extended from the original intake at the bottom of the reservoir to just below a raft at the surface.

4.4.1.2 Raw Water Screen

The first element in the water treatment sequence is a raw water screen. This device is intended to take out heavy materials and debris. The raw water screen is an optional element that can be bypassed. It has not been needed and the bypass piping has been in use since shortly after the plant expansion was completed.



SCHEMATIC FROM DWP 2013 WATER SYSTEM SURVEY REPORT

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

SCALE	
HORIZ:	N/A
VERT:	N/A
DSN.	RCE
DRN.	RCE
CKD.	RCE
DATE:	AUG 13

City of Carlton, Oregon

CITY OF CARLTON WATER TREATMENT PLANT SCHEMATIC

FIGURE 4-3

JOB NUMBER 2674.0000.0

4.4.1.3 Pre-Treatment Unit

The pre-treatment unit is designed to be used during periods of unusually high turbidity in Carlton Reservoir. Its function is to reduce turbidity to levels within the normal treatment range of the standard treatment process consisting of the flocculation tanks and pressure filters. The pre-treatment unit is a PacificKeystone Key-Pac TT designed to operate at 350 gpm.

When the pre-treatment unit is operating alum is added to the influent upstream of the pre-treatment unit to coagulate the particulates into larger masses that more readily settle out of the influent stream. Because the effectiveness of the alum is affected by the pH of the water, soda ash is added as needed for pH adjustment to raise the alkalinity.

As with the raw water screen, this component of the treatment plant was added to the design in response to the extreme conditions which occurred during the 1996 storms. Like the raw water screen, the pre-treatment unit can be bypassed, and has been bypassed since it was installed because it has not been needed.

4.4.1.4 Flocculation Vessels

There are three flocculation tanks at the Water Treatment Plant. One tank was existing at the time of the 2004 treatment plant expansion, and two new tanks operating in series were added with as part of the 2004 construction. Alum and soda ash injection also occurs just upstream of the flocculation tanks.

4.4.1.5 Pressure Filters

As with the flocculation vessels, the total pressure filter capacity consists of a combination of filters that existed prior to the 2004 expansion plus new filters installed in 2004. The filtration systems are designed to run in parallel such that full treatment plant capacity is achieved under normal operations. The two original pressure filters (6’ diameter vertical cylinders) have been rated by the Drinking Water Program for a combined total of 225 gpm. The two 2004 filters (7’ diameter horizontal filters) are rated at 375 gpm each. The result is a total filtration capacity of 975 gpm.

4.4.2 Corrosion Control

The City is currently providing corrosion control by injecting sodium hydroxide for pH control to reduce the amount of lead and copper in private plumbing systems that dissolves into the drinking water. The sodium hydroxide injection point is downstream of the filters.

4.4.3 Iron and Manganese Removal

Iron and manganese control is achieved by the injection of caustic soda, which raises the pH of the water resulting in higher oxidation rates. This is primarily of concern during the summer when iron and manganese concentrations are higher.

4.4.4 Disinfection

Disinfection at the Carlton water treatment plant is done by chlorine injection. Historically this has been done using chlorine gas. The City is currently considering a change to using hypochlorite because of demands placed on chlorine gas handling by OSHA regulations and also based on supply chain considerations. A change to hypochlorite would involve changes to both the injection equipment as well as the SCADA system to provide additional equipment monitoring and alarm signals.

Chlorine for disinfection is injected downstream of the filters and before the clearwell. The clearwell provides contact time for the chlorine before the treated water enters the distribution system.

Table 4-3 WTP General Operating & Design Criteria

Process System	Design Criteria
Raw Water Screen	
Manufacturer	Valve & Filter Corp.
Model	VAF 2000
Flow Rate	100-200 gpm
Piping Connection	6”
Pre-Treatment Unit	
Manufacturer	Pacific Keystone
Model	Key-Pac TT
Flow Rate	350 gpm
Floc Tank Detention Time	20 minutes
Settling Tank Detention Time	60 minutes
Chlorine Injection System	
Manufacturer	Wallace & Tiernan
Model	V-10K
Maximum Feed Capacity	200 lbs/day
Typical Feed Capacity	30 lbs/day
Chemical Injection System	
Chemicals	500 gallons
Aluminum Sulfate	48%
Sodium Hydroxide	25%
Chemical Storage Tanks	500 gallons
Mixers	1/2 hp, 1-phase/60 hz/115 V
Chemical Pump (Original)	LMI Series C
Chemical Pump (Replacement)	Grundfos DME
Pressure Filter System	
Filters 1 & 2	
Influent Pump	
Manufacturer	Cornell
Model	2.5WB-HM
HP	15
Operation	310 gpm @ 100 ft TDH
Floculation Tank	
Diameter	7 ft
Length	18 ft
Detention Time	

Filters (Each, Total of 2)	
Diameter	6 ft
Length	5 ft
Maximum Flow Rate	225 combined total
Filters 3& 4	
Influent Pump	
Manufacturer	Cornell
Model	4RB-VM
HP	30
Operation	825 gpm @ 100 ft TDH
Flocculation Tanks (Each, Total of 2)	
Diameter	8 ft
Length	15 ft
Detention Time	15 minutes
Filters (Each, Total of 2)	
Diameter	6 ft
Length	5 ft
Maximum Flow Rate	112.5

4.4.5 Finished Water Quality

The City's finished water quality from the Carlton WTP is normally very good. As required by ODWS, water from the City water system is tested periodically for bacteriological contamination, organic and inorganic chemical contaminants, disinfection byproducts, and a variety of radioactive compounds.

Based on conversations with City personnel there does not currently appear to be any known problems with water quality under normal conditions.

4.5 FINISHED WATER STORAGE

Finished water storage reservoirs provide at least four important functions as follows:

- They provide a reservoir of water to draw upon during short-term peak system consumption.
- They provide a reserve supply of water to meet fire demands.
- They allow water sources to be taken out of service for repairs or maintenance.
- They help keep system pressures reasonably constant.

The City presently has two finished water storage reservoirs (excluding the clearwell structure at the Water Treatment Plant). These reservoirs are located on separate tax lots west of town on the south side of Meadow Lake Road. The relatively new (2004) 1 MG welded steel reservoir (0.956 MG usable capacity) is about 1.3 miles west of the City Limits while the older 380,000 gallon concrete reservoir is 0.3 miles farther west, or about 1.6 miles west of the City Limits. These two reservoirs typically operate in tandem to provide a total combined storage of 1.378 million gallons.

The evaluation of the storage capacity and hydraulic performance is presented in Chapter 9.

4.5.1 1 MG Welded Steel Finished Water Reservoir

The City's largest finished water storage reservoir is also the newest, completed in 2003 in conjunction with the WTP expansion construction. This reservoir is a 1.0 million gallon (1 MG) welded steel reservoir with a diameter of 72 feet, a water depth of 32.4 feet to overflow (sidewall height of 35.2 feet), a bottom elevation of 339.0 and an overflow elevation of approximately 371.4 (±2.8 feet below the top of the side walls). This reservoir is set entirely above grade, and vehicular access is available to all sides of the reservoir. Assuming the top of the operational range is 1 ft below the overflow, this reservoir has a maximum capacity of 0.956 MG, which is rounded to 1 MG for general reference.

The reservoir has three floor penetrations including a 16-inch inlet, a 16-inch outlet, and an 8-inch overflow. Both the inlet and outlet have a 6" tall silt ring. The inlet pipe runs under the reservoir to the back while the outlet and overflow pipes are near the front of the reservoir toward the transmission piping. Coming from the west the inlet piping runs south up the hill from Meadow Lake Road to the reservoir in a 16-inch pipe, after flowing through the reservoir the water runs back north to Meadow Lake Road in a separate 16-inch pipe. **Figure 4-4** shows the piping layout for the 1 MG reservoir.

Under normal circumstances the water level for both reservoirs is controlled by the water elevation in the concrete reservoir which is upstream of this reservoir. As water is used in town the water in the steel reservoir drops first since it is the most directly connected to the transmission main. When the water surface in the steel reservoir drops, water flows from the concrete reservoir to the steel reservoir. Control of the water level in the concrete reservoir is discussed below.

Overflow piping consists of a cone that tapers from 18-inch diameter at top to 8-inches at the bottom which is attached to the top of the vertical 8-inch overflow pipe. The overflow line drains to the roadside ditch at Meadow Lake Road. The water level in this reservoir is monitored with the use of a mechanical half-travel level indicator, as well as a level transmitter connected to the WTP SCADA system.

This reservoir is also equipped with an electrically controlled valve on the inlet piping that allows the reservoir to be operated in a standalone condition if the concrete reservoir is taken off line. The pressure transmitter would provide water level information to the SCADA system which would in turn open and close this control valve based on water level set points in the control system.

From this reservoir, water flows to the distribution system through the transmission line in Meadow Lake Road. Water system pressure downstream of the steel reservoir is governed by the water surface elevation in the reservoir.

4.5.2 380,000 Gallon (0.38 MG) Concrete Finished Water Reservoir

The City's other finished water storage reservoir is an in-ground concrete reservoir with a wood roof structure that dates to around 1918. The concrete structure is roughly 74 feet long, 62 feet wide with an average depth of about 11, feet providing approximately 380,000 gallons of storage. The covering for this reservoir consists of a wood frame structure with relatively short plywood sidewalls and a metal roof sloped up at 6/12 to the center ridge.

This reservoir also has three pipes, all connected to the north (road) side on the eastern half. The western pipe is the inlet line running from a control valve vault to the reservoir with a manual shutoff valve just outside the reservoir. The eastern line, also equipped with a manual shutoff valve by the reservoir, is the discharge line running back to the transmission main adjacent to Meadow Lake Road. In between these two pipes is an overflow line that drains to the Meadow Lake Road ditch.

The water level in the concrete reservoir is controlled by a Cla-Val control valve located in a vault on the transmission main by Meadow Lake Road. A float switch in the concrete reservoir provides a signal to a solenoid valve that is a component of the Cla-Val control valve. The solenoid valve operates the pilot mechanism on the Cla-Val signaling when to send water into the concrete reservoir and when to stop the flow. **Figure 4-5** shows the piping layout at this reservoir.

There is no flow control on the discharge side of the concrete reservoir. If upstream flow from the WTP exceeds demand from the distribution system, the water surface of both the concrete and steel reservoirs will rise together and the water would overflow if the Cla-Val did not stop flow. If demand from the distribution system exceeds the flow from the WTP, the water will be drawn from the steel reservoir, and as the steel reservoir water level falls it will draw water from the concrete reservoir.

There is also a pressure reducing valve (PRV) on the transmission main in the vault upstream of the concrete reservoir. This PRV was originally intended to allow the town to be served if the concrete reservoir needed to be taken off line. With the 1 MG steel reservoir and its associated actuated control valve, the concrete reservoir can now be bypassed with control transferred to the steel reservoir, so this PRV is no longer needed and can be removed from the system.

Finally, we want to mention that we are unaware of reliable field survey data relating to the concrete reservoir or the tax lot upon which it sits. Due to the lack of this information we recommend that the City include such a field survey as part of any preliminary design work that would affect the infrastructure at the concrete reservoir site.

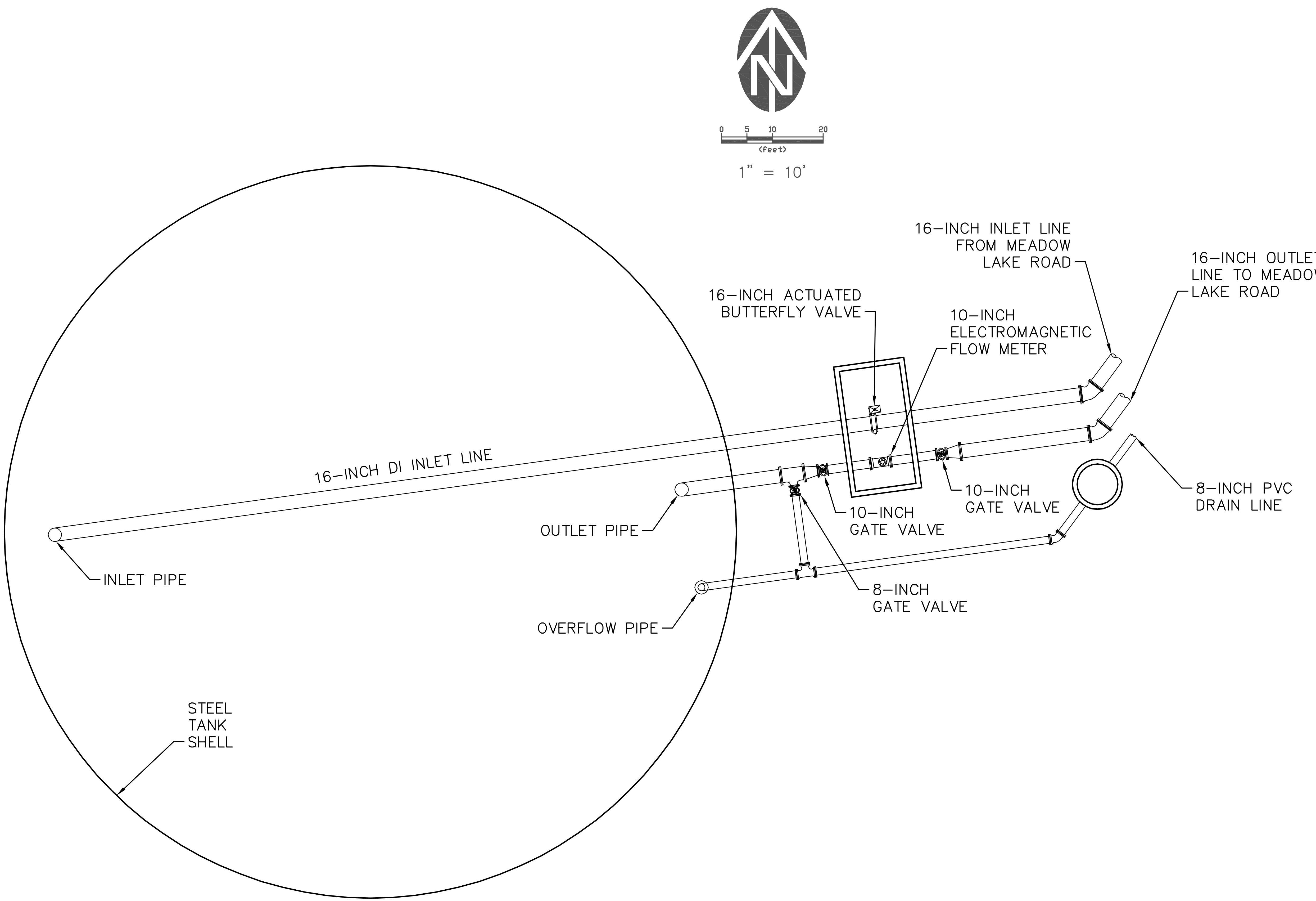
4.6 DISTRIBUTION SYSTEM

The term distribution system as used here relates to the piping and associated appurtenances used to convey the water from the water treatment plant to the end user. For the purposes of this report the distribution system is divided into three main categories:

- Treatment Plant Finished Water Line
- Meadow Lake Road Transmission Main
- Distribution Mains

The Treatment Plant Finished Water Line carries flow from the treatment plant to the Concrete Finished Water Reservoir. The Meadow Lake Road Transmission Main runs from the Concrete Finished Water Reservoir to town. And finally the Distribution Mains provide the network of piping that loop through the service area providing fire protection as well as connections to the end users.

As discussed above the City’s water system infrastructure dates to the early 1900s and by 1936 the City had a very well developed water distribution system. As the City expanded, as demand grew, or as older pipes failed, the distribution system has continued to be expanded and upgraded since that time. The result is a pipe network of many different materials, ages and conditions in existence today.



City of Carlton, Oregon

1 MG STEEL RESERVOIR SITE PIPING DIAGRAM

FIGURE 4-4

JOB NUMBER 2674.0000.0

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

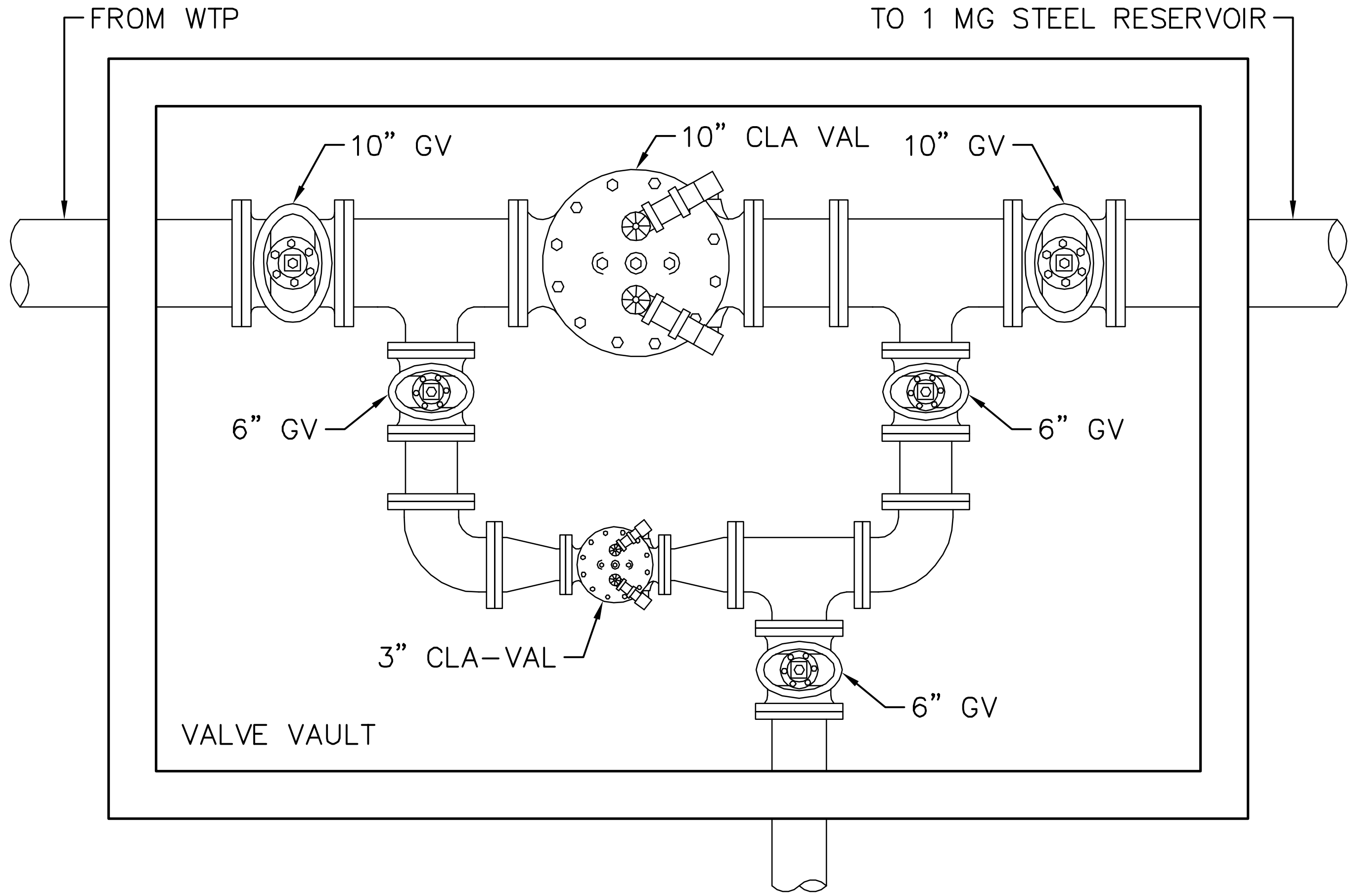
VERIFY SCALE
BAR IS ONE-HALF INCH ON ORIGINAL DRAWING
0 .5"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

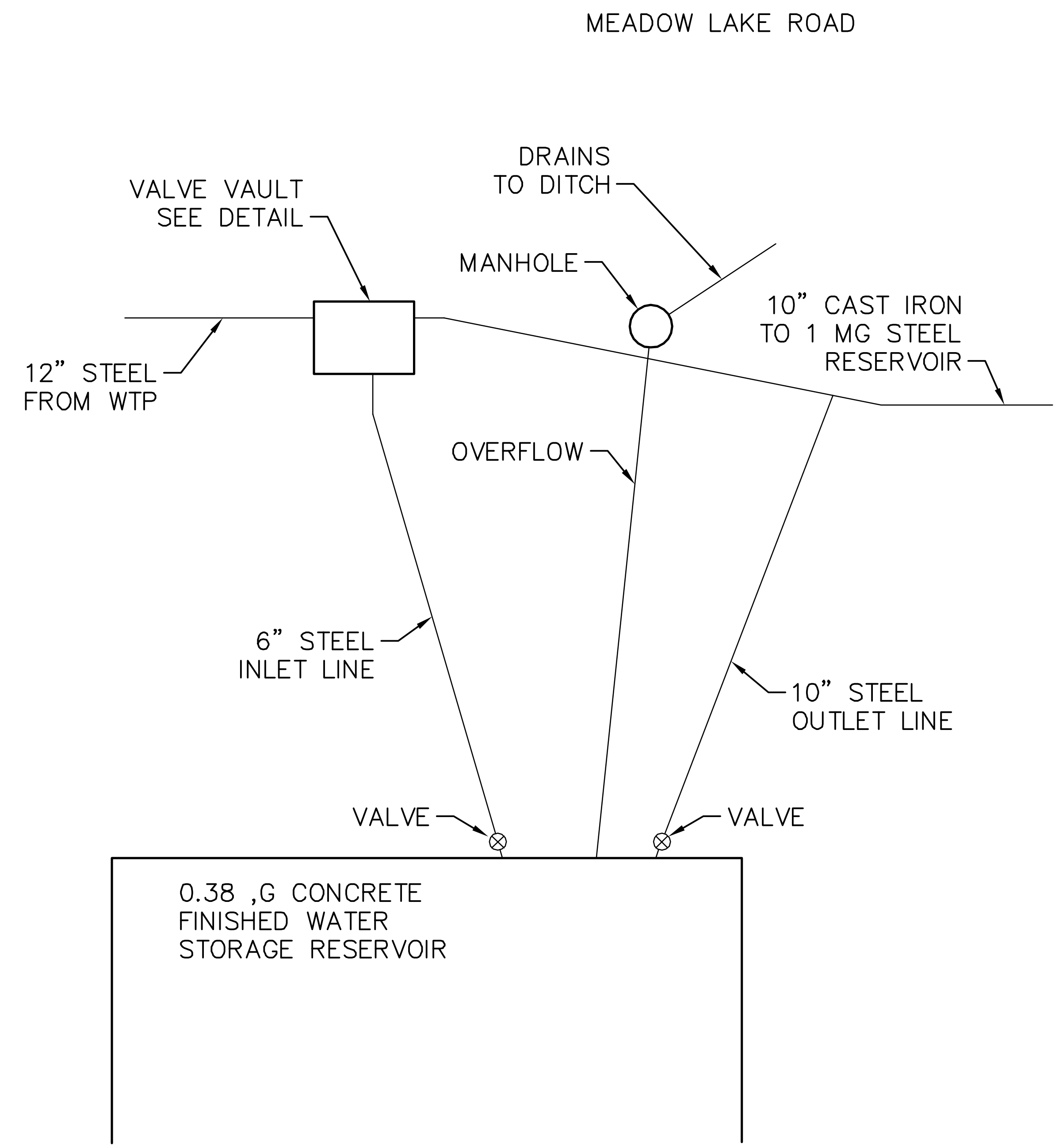
DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

8/27/2013 1:51:31 PM
R:\Maps\City Utility Maps\Carlton\Maps\Water MP Exhibits\4-4 Steel Reservoir Piping.dwg, (1117 tab)





NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

VERIFY SCALE
BAR IS ONE-HALF INCH ON ORIGINAL DRAWING
0 .5"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

City of Carlton, Oregon

0.38 MG CONCRETE RESERVOIR
SITE PIPING DIAGRAM

FIGURE
4-5

JOB NUMBER
2674.0000.0

One of the most important facts about the distribution system as it stands today is that while it serves daily demands well, it is undersized and inadequate for providing the desired fire flow capacities. As such a key concern for the system is identifying those improvements needed to increase fire flow capacity to the levels expected by modern fire flow requirements.

4.6.1 Pipe Network

The general location of the Treatment Plant Raw Water Line and the Meadow Lake Road Transmission Main are shown on **Figure 4-1**. **Figure 4-6** shown the City Limits/UGB area and the current distribution main network. Summaries of the pipe sizes and materials for the current pipe network are provided in **Tables 4-4 through 4-6**.

Although public waterlines within the study area are generally owned by the City, there are three separate entities which have jurisdiction over the right-of-ways within which the water mainlines are located. In addition to the City, the Oregon Department of Transportation (ODOT) has jurisdictional oversight for facilities constructed within ODOT right-of-way (Highway 47), while Yamhill County has jurisdictional oversight for facilities constructed within County right-of-ways.

Table 4-4 Treatment Plant Finished Water Line Pipe Summary
(Distances in Feet Unless Otherwise Noted)

	Pipe Diameter				
Pipe Material	6-inch	10-inch	12-inch	16-inch	Total
Steel	60	7,310	29,900	-	37,270
Total	60	7,310	29,900	-	37,270 (7.03 miles)

Table 4-5 Meadow Lake Transmission Main Pipe Summary
(Distances in Feet Unless Otherwise Noted)

	Pipe Diameter				
Pipe Material	6-inch	10-inch	12-inch	16-inch	Total
Ductile Iron	-	-	-	1,435	1,435
Cast Iron	-	7,887	-	-	7,887
Total	-	7,887	-	1,435	9,322 (1.77 miles)

Table 4-6 Distribution Main Pipe Summary

	Pipe Diameter							
Pipe Material	2-inch	3-inch	4-inch	6-inch	8-inch	10-inch	12-inch	Total
PVC	2,757	-	713	4,496	6,375	-	-	14,341
Ductile Iron	-	-	-	1,218	7,307	5,593	1,725	15,843
Cast Iron	-	-	9,493	9,936	737	1,620	-	21,786
Galvanized Iron	1,337	-	-	-	-	-	-	1,337
Steel	-	269	580	514	-	-	-	1,363
Unknown	1,547	-	3,510	2,967	-	-	-	8,024
Total	5,641	269	14,296	19,131	14,419	7,213	1,725	62,694
								11.88 mi

Note: Pipe totals do not include Valley View Water Company or East Carlton Water Company pipes.

Figure 4-7 Distribution Pipe Inventory by Material Type

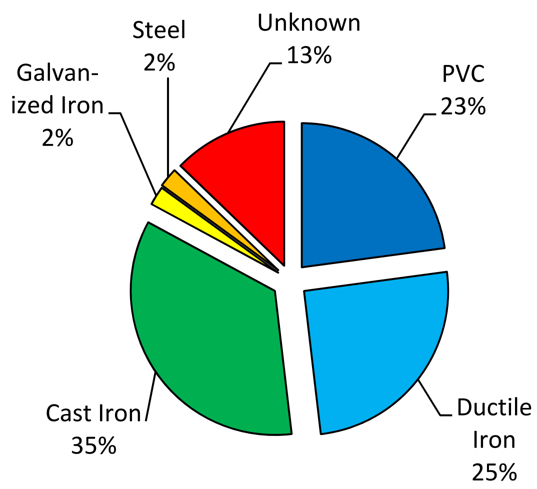
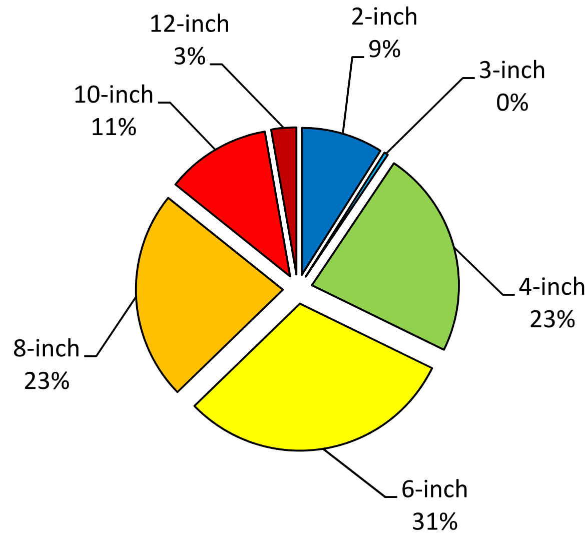
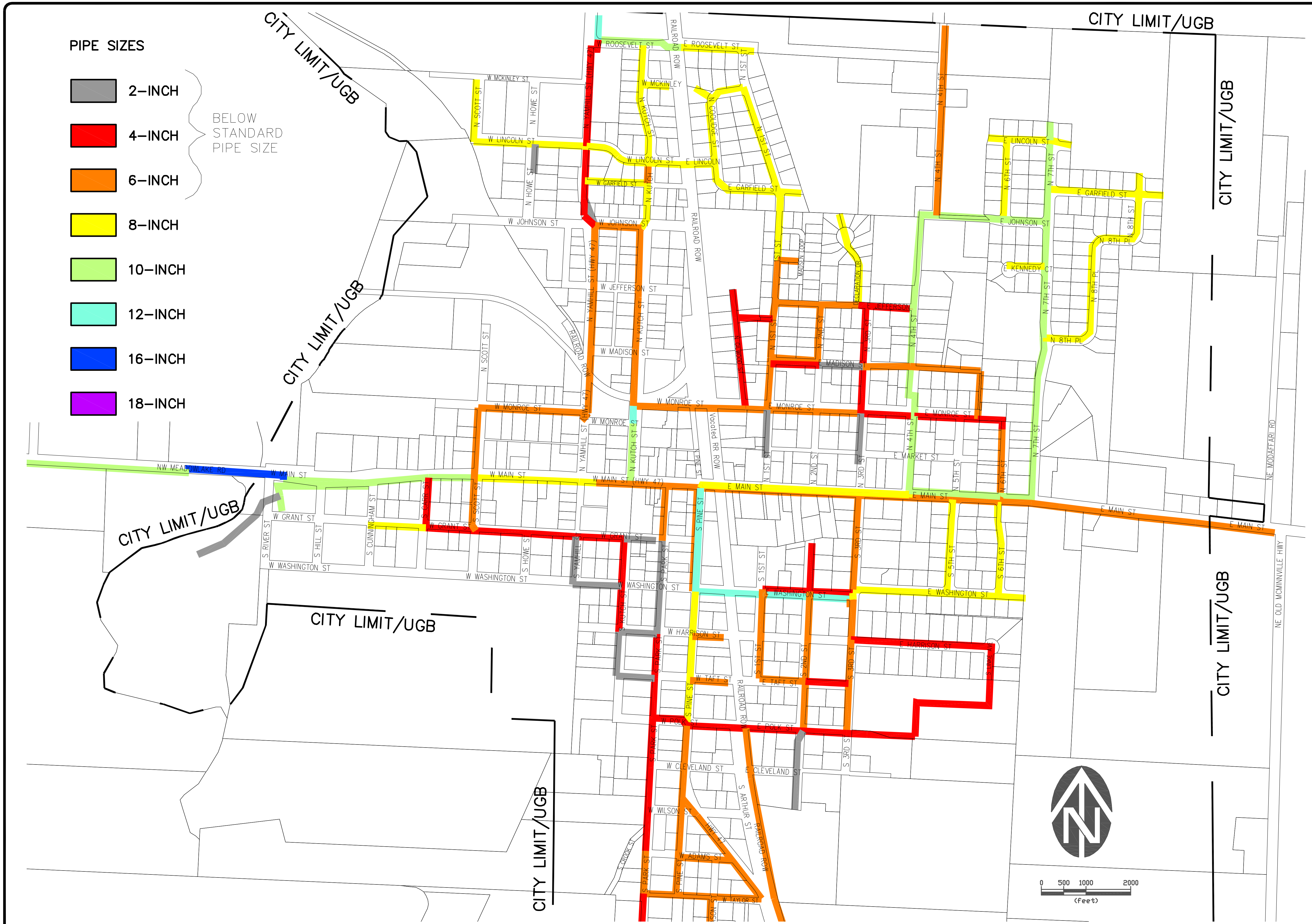


Figure 4-8 Distribution Pipe Inventory by Diameter





VERIFY SCALE
BAR IS ONE-HALF INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

City of Carlton, Oregon

EXISTING DISTRIBUTION MAIN SYSTEM MAP

FIGURE
4-6

JOB NUMBER
2674.0000.0

The City's PWDS standardize the type and size of piping materials used for the expansion or rehabilitation of the distribution system. These standards specify that all new main line pipe within the City be Class 52 Ductile Iron. The standards require that new waterlines be looped and valved such that the removal of any single line segment from service will typically not result in more than one fire hydrant being taken out of service.

The layout of the existing water system appears to be adequate to deliver the required domestic flow rates to the community. However, the system fire flow capacity is inadequate virtually throughout the City Limits/UGB service area. The lack of fire flow capacity is caused both by the size of the Meadow Lake Road Transmission Main, as well as the Distribution Main network inside the City Limits/UGB. Ultimately both the transmission main and distribution mains must be improved for fire flow capacity to be substantially increased.

Much of the older pipe in the distribution system does not meet the current standards, either for size or material type. As extensions, repairs or alterations are made to the undersized portions of the distribution system, it is advisable that the new components conform to the current standards and conform with size recommendations as discussed under recommended distribution improvements in Chapter 8.

4.6.2 Water Service Levels

Water must be supplied to the customers at sufficiently high pressures to prevent contamination and to ensure that appliances operate correctly. Excessive pressures must also be avoided to prevent damage to the distribution system and private plumbing fixtures. City standards provide for a typical working water pressure of approximately 70 psi with a range between 40 and 100 psi. With the exception of the rural water customers served by the Water Treatment Plant Finished Water Line, the City currently has only one water service level served by gravity from the existing 1 MG steel reservoir. Under typical (non-fire flow) conditions, the reservoir is sufficient to provide 40 psi of residual pressure up to an elevation of approximately 250-260 feet, while the residual pressure remains below 100 psi for elevations above roughly 130 feet. A review of the ground surface elevations within the City Limits/UGB show that all areas are between the elevations of 130 feet and 260 feet.

4.6.3 Water Meters

Based on City records there are approximately 891 water service accounts currently active. The breakdown of these meters by billing code and whether they are residential or business is shown in **Table 4-7**. **Table 4-8** provides a listing of meters larger than 1-inch by meter size and location.

.

Table 4-7 Water Meter Account Summary

	Residential	Business
In Town Single Rate	721	43
Outside City Single	93	6
In Town Double Rate	5	5
In Town Triple Rate	1	-
In Town Quad Rate	1	-
In Town 15 Rate	1	-
Out Of Town, By Wtp	-	1
In Town 38 Rate	1	-
Valley View Water Dist	0	1
Out Of Town Double R	-	1
In Town Seven Rate	3	-
Out Of Town Triple	0	1
In Town 17 Rate	1	-
In Town Public	6	-
	833	58
Total	891	

Table 4-8 Water Meters Larger Than 1-inch

Inside City Limits/UGB	
420 S. 3rd Street (Elementary School)	4"
750 W. Lincoln Street (Cuneo Cellars)	2"
801 N. Scott Street (Carlton Winemakers Studio)	2"
236 N. Kutch Street (Ken Wright Cellars)	2"
116-132 W. Main Street	2"
225 W. Grant Street (City Pool)	2"
1003 W. Grant Street (Wennerberg Park)	2"
Outside City Limits/UGB	
Valley View Water District (Meter at north end of Yamhill Street)	4"
10600 NW Westside Road (Carlton Farms)	3"
11305 NW Westside Road	2"

4.6.4 Fire Hydrants

A review of existing records shows that the City has approximately 90 fire hydrants. The City's current design standards require the Mueller Super Centurion 250, Model A423 for use in the City, although there are still many old, substandard hydrants in the system. The Mueller Super Centurion 250, Model A423 has (2) 2.5-inch hose ports (NST) and (1) 4.5-inch pumper port (NST). Hydrants in the distribution system are generally well distributed around the system, providing some level of coverage to nearly all of the developed areas. As with any municipality, there are a number of instances where hydrant spacing exceeds the recommended spacing.

The City's PWDS require that all new hydrants be connected to the distribution main with a minimum 6-inch diameter lateral. It is recommended that as hydrants are replaced that the lateral diameter is also evaluated to ensure compliance with the standard.

4.7 SCADA & TELEMETRY SYSTEM

The City currently has a supervisory control and data acquisition (SCADA) system located at the WTP that allows for centralized monitoring and control of the system by the system operators. The system is based on a programmable logic controller (PLC) that controls both the WTP operation plus provides limited data monitoring an valve control at the 1 MG Steel Reservoir site.

The system includes a graphic based SCADA interface that allows system operators to access the main PLC system through a desktop computer. Measured variables can be viewed, trended and saved on the computer, and operating parameters can be changed. The computer-based interface also provides centralized alarm management with stored alarm logs. The City also has a laptop configured for remote access to the SCADA system to allow programming and troubleshooting of the SCADA system from any remote site.

4.8 WATER SYSTEM SURVEY RESULTS

As previously noted, ODWS conducts a sanitary survey of each public water system on a regular basis. For Carlton the Water System Survey was conducted on July 9, 2013, with the letter report to the City dated July 15, 2013. Overall the water system facilities were noted to be well operated and maintained by knowledgeable and competent staff. The Survey did identify items requiring attention and action by the City which are outlined below.

ODWS noted that turbidity profiles have not been performed at least quarterly as required by OAR 333-061-0076(4)(a)(E). The lack of turbidity profiles meant that filter operations could not be managed and optimized based on the turbidity profiles as should occur.

ODWS also indicated that the existing water system operation and maintenance information does not satisfy the requirements of OAR 333-061-0065(4) for an O&M Manual. ODWS provided O&M development guidance to the City via an attachment to the Water System Survey Report.

Several structural/physical concerns were noted for the finished water storage reservoirs. These were:

- Repair all loose or detached fascia/trim boards on Old Reservoir
- Complete inspection and screening of all openings into Old Reservoir building to ensure sanitary closure
- Excavate the debris around drain/overflow pipe terminus of Old Reservoir pipe to ensure unimpeded flow from the pipe. Verify screen integrity
- Replace screen on drain/overflow pipe from New Reservoir

A question was raised regarding the discharge rate from the clearwell to the distribution system. The 2010 Tracer Study was mentioned as containing a flow limit of 473 gpm, and a minim water surface elevation of 17 feet. Should the City wish to discharge from the clearwell at rates above 473 gpm a new tracer study is needed to determine the parameters under which higher flow may be allowable. Tracer studies can be obtained through ODWS at no cost to the City.

The chemical feed pump calibrations must occur at least once per year, and the calibration curves retained in the file. Sample calibration curves were provided with the Survey report.

4.9 EXISTING WATER SYSTEM FUNDING MECHANISMS

Funding for the City's existing water system comes from two major sources, user fees and System Development Charges (SDCs). Since SDCs can't be used to finance operation, maintenance and replacement costs of a water system, the O&M and repair/replacement costs must be financed from user fees.

4.9.1 Water User Rates

The City's water fund must provide sufficient revenues to properly operate and maintain the water system and provide reserves for normally anticipated replacement of key system components such as pumps, motors, hydrants, waterlines, valves, etc. Although the City relies exclusively on water user fees for operation and maintenance of the water system, the water fund cannot typically finance major capital improvements without outside funding sources.

The existing monthly user rates are determined by adding a fixed base charge to a volume charge for water consumed in excess of 500 CF. The base charge per account is fixed for in-town residents at $40.06 and for those outside the City Limits/UGB at $42.75. A volume charge is also added for additional water consumed above 500 CF. The current water user rates are listed in **Table 4–9** (see **Appendix D** for a copy of the user rate resolution). The water use resolution also establishes the procedure for establishing the number of EDUs for water users other than single family residential units, or for users with higher than average water usage.

Table 4-9 Existing Water User Rates

Cubic Feet	Inside City Limits (1)	Outside City Limits (1)
Base Rate per Account 0 – 500	$40.70	$43.43
501 – 1000	$3.35/100 CF	$4.04/100 CF
1001 & up	$3.35/100 CF	$6.45/100 CF

(1) Water rates effective as of July 1, 2013

Assuming an average residential consumption of 100 gallons/capita/day, an average household size of 2.8 residents/household and a 30 day month (8,400 gallons, or 1,122 cubic feet), the typical monthly user charge (for in-City users) would be approximately $60.80 for a single family residence. For per capita usage rates or household sizes that are different from these assumptions, the monthly user charge will change proportionally.

4.9.2 System Development Charges

Carlton's SDCs are based on the size of the water meter size per **Table 4-10**. SDCs are used for capital improvement projects which increase system capacity. The SDCs consist of two portions, reimbursement fee and the improvement fee. The reimbursement fee portion is the only portion of the SDC that is guaranteed to be available to the City to use towards repayment of loans for capital improvement projects, since the improvement fee portion of the SDC is available as an SDC credit for developers who complete water system projects that are identified in the City's CIP (on which the SDCs are based). The total price for SDCs range from $3,633 for 5/8-inch and ¾-inch water meters to $38,752 for an 8-inch water meter. Approximately 7% of the SDC fee schedule is the reimbursement fee portion, while remaining 93% is the improvement fee portion.

Table 4-10 Water SDC Schedule

Meter Size	Reimbursement Fee	Improvement Fee	Compliance Cost	Total Water SDC
5/8 and 3/4 Inch	$4,218	$1,827	$265	$6,310
1 Inch	$4,218	$1,827	$265	$6,310
1 ½ Inch	$14,046	$6,084	$882	$21,012
2 Inch	$28,135	$12,187	$1,768	$42,090
3 Inch	$67,488	$29,232	$4,240	$100,960
4 Inch	$118,104	$51,156	$7,421	$176,681
6 Inch	$257,298	$111,447	$16,167	$384,912
8 Inch	$449,935	$194,887	$28,269	$673,091

4.10 RECOMMENDATIONS

The intent of this chapter is to provide an inventory and summary of the existing water system and existing conditions. Subsequent sections of this report, as detailed in the table of contents, evaluate the various components of the water system and present detailed improvement plans for the system as a whole. Recommendations related to specific improvements are contained in the subsequent chapters.

CHAPTER 5

PRESENT AND FUTURE WATER DEMANDS

Chapter Outline

PRESENT AND FUTURE WATER DEMANDS

CHAPTER 5

5.1 INTRODUCTION

A primary measure of the size of a municipal water system is the total amount of water that it delivers to consumers. This capacity is the sum of water required for domestic, commercial, and industrial uses, water that is lost out of the system through leakage, in addition to water required for fire protection.

Future water demands have been prepared based on a number of variables including the following:

- Population projections
- Historical water demand
- Land use zoning within the study area
- Projected fire flows

The demand characteristics developed in this chapter will serve as the basis for evaluating the City's existing water system infrastructure and for sizing supply, treatment, storage, and distribution infrastructure across the planning period.

5.2 TERMS AND DEFINITIONS

5.2.1 System Demand

The following terms are used to describe system demand:

- *Consumption* – Consumptive demand is water delivered to the system's users through service connections. Consumption is generally less than demand, the difference being system loss. Consumption is measured by the consumer's meter and is accordingly the metered portion of demand.
- *Demand* – The total amount of drinking water entering the transmission/distribution system from water sources and storage facilities to meet various user needs (excludes raw water that has not passed through the WTP and backwash water). Demand equals consumption plus system loss and is usually measured by system master meters.

  (Note: For Carlton, Demand is measured by the master meter just downstream of the WTP Clearwell. While the City's data system tracks the output from this meter the data is not permanently recorded. Therefore, Demand for this study was calculated using the treatment filter meters, the filter backwash meter, and estimating other WTP water uses.
- *Diverted* – The total quantity of water removed from the water source. A water right provides the authorization for taking a specified amount water for a designated purpose. The term "Diverted" used within the context of this report is the basis for comparison with the City's water rights when looking to see whether or not the City has legal access to adequate quantities of water.
- *Fire Flow Demand* – Demand required for firefighting purposes. Fire flow demands vary by structure type and use and are proscribed by the City and/or the fire code. Fire flow demand is considered to be met if the system can deliver the required flow rate while maintaining a minimum residual pressure in the distribution system of 20 psi.

- *System Loss* – System loss is water that cannot be accounted for. It is the difference between the total system demand and the total consumption. System loss is not necessarily the same as leakage. Although the majority of system losses are typically the result of leaks, losses can also be attributed to meter error, as well as unmetered uses such as street flushing, hydrant testing and similar activities, or from bypasses, overflows, etc.

In basic math format:

Demand = Diverted – Water Treatment Plant Processes

System Loss = Demand – Consumption

5.2.2 Demand Variations

Water demands in municipal water systems vary widely across time. Seasonal, monthly, daily and hourly demand rates are utilized to evaluate and size various components of the overall water system. For the purposes of this report, the following demand classifications will be used. The definitions are generally listed in order of increasing magnitude.

- *Average Day Demand (ADD)* – The total volume of water that enters the system over a period of one year, divided by 365 days.
- *Maximum Month Demand (MMD)* – The largest total volume of water that enters the system in a one-month period, divided by 30 days.
- *Maximum Day Demand (MDD)* – The largest total volume of water that enters the system in a 24-hour period. MDD is commonly used to size water treatment plants, large diameter transmission mains and factors into the sizing of reservoirs.
- *Peak Hour Demand (PHD)* – The greatest flow occurring in any one-hour period. PHD is used as one criterion for sizing distribution waterlines and factors into the equations used to size pump stations and reservoirs.

5.3 POPULATION

Population projections serve as the basis for future water demand projections. Much of the challenge in projecting water system growth relates to the difficulty in accurately tracking or projecting actual populations.

This section evaluates anticipated growth from a review of several data sources; including historical population data (census information & PSU estimates), County coordinated population projections, and anticipated development.

5.3.1 Historical Municipal Population

Population histories provide a tool for determining the future growth rate of the municipal water system. The population in Carlton has increased from approximately 1,126 people in 1970 to 2,007 in 2010, though the growth was not uniform. As shown in **Figure 5-1**, after losing population during the 1980s recession, the City grew by an average of 1.62%/year in the 1990s and by 1.73%/year during the 2000s.

The City's population projections only take into account population within the City Limits/UGB. The population connected to the City's water system outside the City Limits/UGB is not explicitly known. While population estimates for users outside the City Limits/UGB could be made, such was determined unnecessary for the purposes of this study. Those outside the City Limits/UGB connected to the City water system are connected on the basis of long term historical standing or special needs, and all such connections are governed by specific rules and/or agreements. State law generally prohibits municipalities from providing water service to properties outside its jurisdiction. Because of this, future connections to the City water system outside the City Limits/UGB are expected to be extremely limited. Thus, for this report Consumption outside the City Limits/UGB is assumed to be unchanging (not increasing in proportion to population growth).

5.3.2 Anticipated Future Development

Carlton is expected to experience continued moderate growth in the future, generally due to its proximity to the Newberg and McMinnville areas. Both areas have a comparatively larger employment base but less affordable housing than Carlton does. During the planning period, the City anticipates future residential development to continue as both new subdivisions and as infill development (i.e. partitions & redevelopment). Major commercial or industrial developments that would dramatically increase the employment opportunities in Carlton are not anticipated during the planning period.

5.3.3 Future Population Projections

As previously noted, the planning period used by this master plan for public water facilities is 20 years. In order to be eligible for many public funding sources, population projections (and associated demand projections) must be shown to be compatible with local and statewide planning goals, including adopted statewide and County population allocations (which are used as the 'coordinated number' for evaluating population projections). Carlton's population projection is based on the "Population Forecasts for Yamhill County, its Cities and Unincorporated Area 2011-2035" which projects an average growth rate of 1.47% through 2035, resulting in a 2033 population of 2,807. Documentation for this coordinated population number and the associated growth rate appears in **Appendix E**.

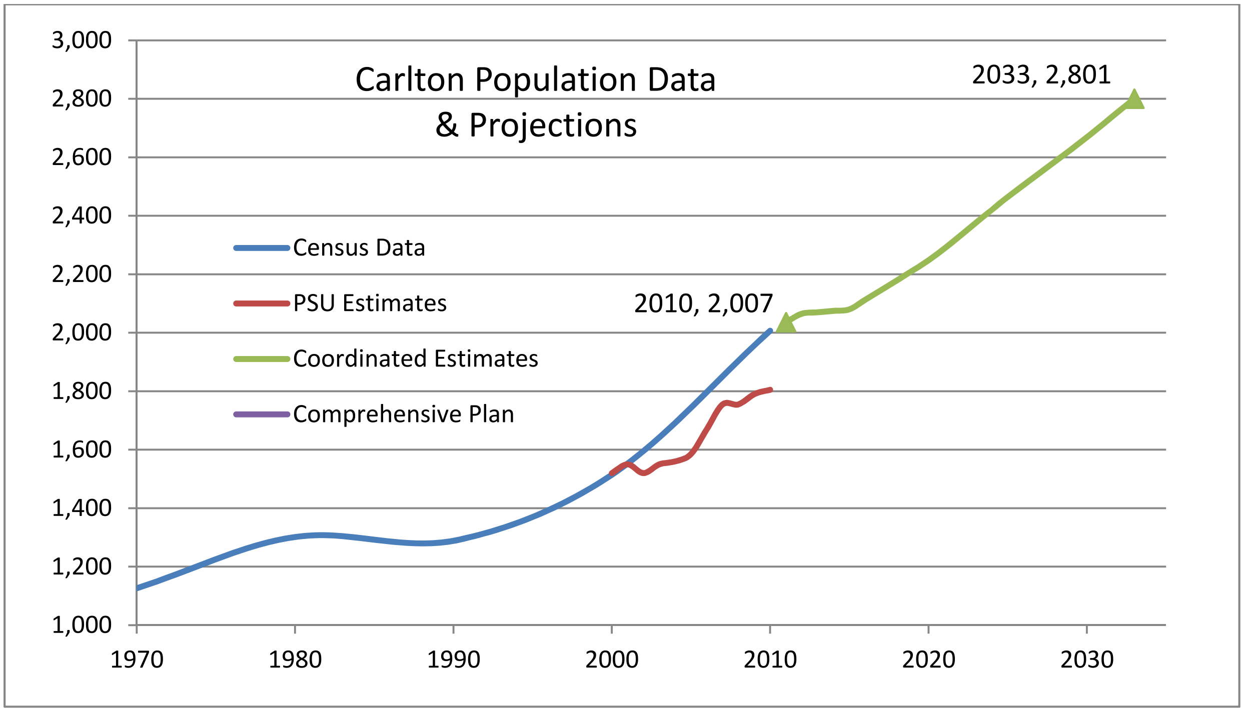
The City believes the population growth may remain slow for the next several years due to the down economy, but will then return to historic levels (similar to the return of development after the slowdown of the 1980s). The adopted County coordinated population of 2,807 through 2033 will be utilized for the remainder of this master plan. A tabulation of population data for select years during the planning period is presented in **Table 5-1,** as shown graphically in **Figure 5-1**.

In addition to presenting the coordinated population data, Figure 5-1 also shows Carlton's census population from 1970 to 2010, the PSU annual population estimate from 2000 to 2010, and the prior coordinated population data that was used in Carlton's 2000 Comprehensive Plan (amended in 2007 and 2009).

Table 5-1 Population Projection Summary

Year	Projected Municipal Population
2010	2,007
2015	2,080
2020	2,247
2025	2,465
2030	2,669
2033	2,801

Figure 5-1 Municipal Population Projections



5.4 HISTORICAL WATER DEMAND

Historical Water Treatment Plant records provided by the City were evaluated to determine usage rates and demand fluctuations. For a variety of reasons, including changes made to record keeping systems and data, the four year period from 2009-2012 was selected for use in this report. Furthermore, because of additional data irregularities in the 2009 data, while the available 2009 data will be presented, it is not used in calculations or projections. Given the overall consistency of the data the three year period is considered sufficient for making the necessary projections of future demand.

5.4.1 Water Production

As previously discussed, the City currently obtains all of its municipal water supply from the Carlton Reservoir impoundment on Panther Creek. As described above, traditionally Demand is used as the primary basis for evaluating water system needs. For consistency with standard practice, this report will generally follow that convention. However, due to some of the unique characteristics of the Carlton water system, the key Demand parameters will be calculated in a way that reflects those unique characteristics. The calculations and the reasoning behind them will be spelled out in the following sections.

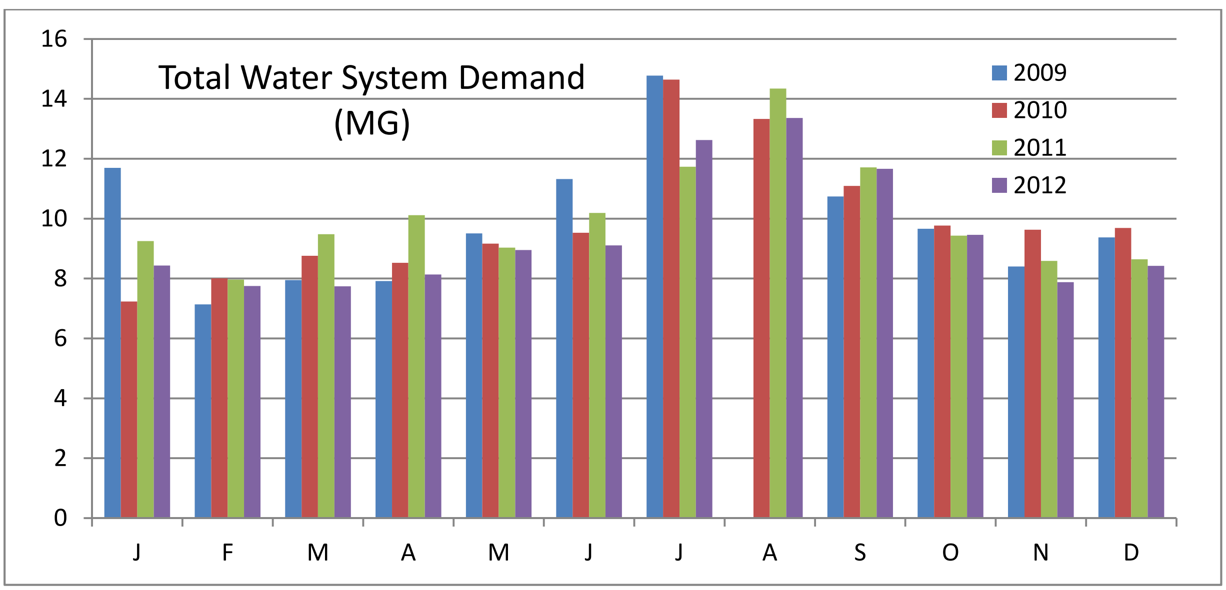
As a starting point, **Table 5-2** presents the calculated system Demand for the years 2009-2012, while **Figure 5-2** presents the same data is graphical format. This data represents the total quantity of water leaving the water treatment plant and entering the transmission main headed for town.

Table 5 - 2 Carlton Water System Demand (in MG)

	J	F	M	A	M	J	J	A	S	O	N	D	Total
2009	**11.70**	7.14	7.95	7.92	9.51	11.32	14.78	**0.00**	10.74	9.66	8.40	9.37	N/A
2010	6.85	8.01	8.76	8.52	9.17	9.53	14.64	13.33	11.09	9.77	9.63	9.69	119.0
2011	9.25	7.96	9.48	10.12	9.03	10.19	11.73	14.34	11.71	9.43	8.59	8.64	120.5
2012	8.44	7.75	7.74	8.14	8.95	9.11	12.63	13.36	11.66	9.46	7.88	8.43	113.5

January 2009 data is considered unusually high and is not consistent with comparable data.
August 2009 is unavailable due to meter problems and changes.

Figure 5-2 Historical Water Demand by Month (2009-2012)



Overall the data presents a picture of water use in Carlton that provides a reasonable foundation for projecting future water use. Demand in the winter months is largely consistent from month to month and year to year. As expected, Demand in the summer is significantly higher, and to a reasonable extent demand variations can be correlated with specific temperature and rainfall conditions.

Figure 5-3 Historical Average Temperature by Month (2009-2012), McMinnville Weather Station

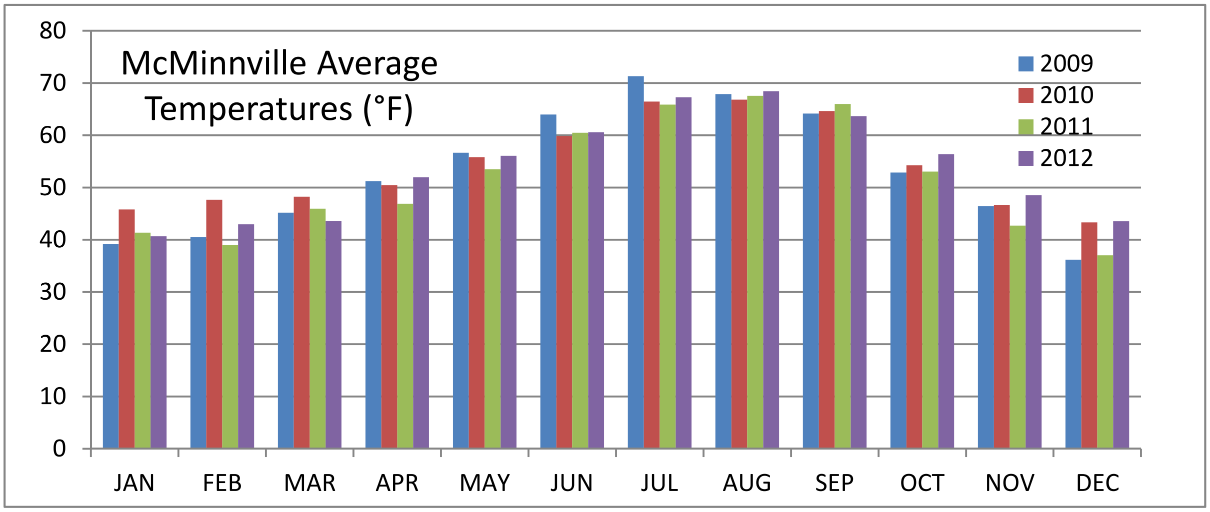
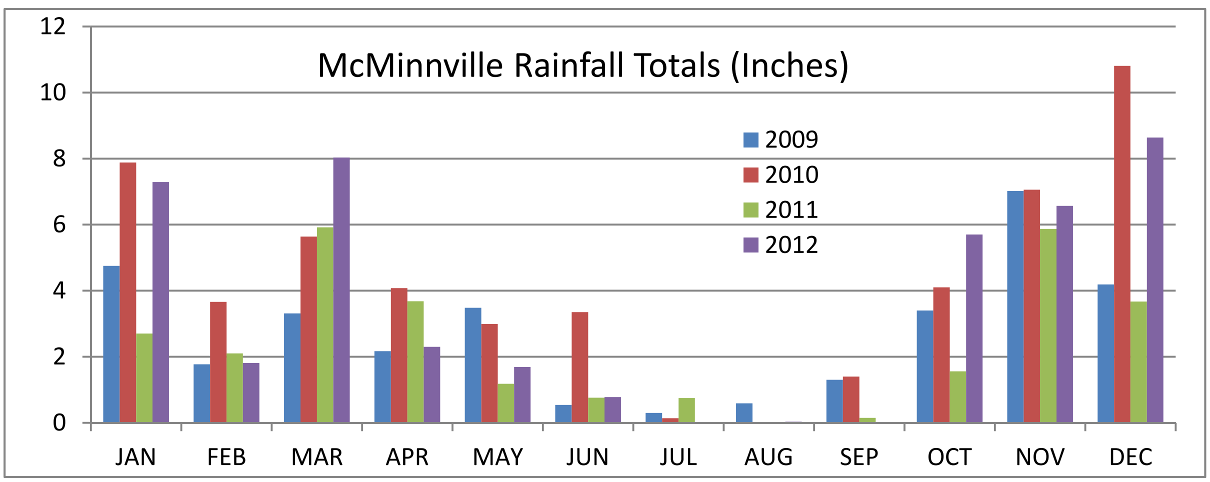


Figure 5-4 Historical Total Rainfall by Month (2009-2012), McMinnville Weather Station



5.4.2 Average Day Demand (ADD)

As defined above, water demand is defined as the sum of all water produced and delivered to the City distribution system. It includes water consumed in all use categories and also includes system loss (both leakage and other unaccounted-for water). Water demand varies across seasonal periods, days of the week, and hours of the day. The establishment of an Average Day Demand rate serves as the baseline against which other more intensified demands are measured.

Traditionally, the division of the ADD by the population allows the projection of future demands based on population growth. However, for Carlton the significant quantity of water use and the significant transmission main water losses occurring outside of the City Limits/UGB need to be properly factored into Demand values projected into the future.

Starting with the traditional calculation **Table 5-2** is adapted below to look at the annual Demand totals for 2010 through 2012, and adjusted for population to calculate the standard Average Day Demand in gallons per person per day (gpcd) as presented in **Table 5-3**.

Table 5 - 3 Carlton Water System Average Day Demand

	Total Demand (MG)	Population	Total Demand (gpcd)
2010	119.4	2007	163
2011	120.5	2036	162
2012	113.5	2065	150
Average			158

As just mentioned, the intent for this study is to treat consumption and losses inside the City Limits/UGB differently than consumption and losses outside the City Limits/UGB. In the course of this study substantial effort was required to properly categorize and organize the available water system data. Initial data analysis indicated total system losses of roughly 50%. This was not in agreement with leak detention study results showing much lower losses. To verify the reliability of the data and confirm a proper understanding of the various measurements, a water balance summary was created that organized and tracked water system quantities starting at Carlton Reservoir, through the water treatment plant, identified losses and consumption between the water treatment plant and the concrete and steel water storage reservoirs, and also identified losses and consumption downstream of the storage reservoirs.

The details of this effort are not specifically necessary to the current discussion, but do provide a useful background in understanding where water is being used, and where it is being lost within the Carlton water system. The net result of that water balance analysis is that while losses are not 50%, they are on the order of 40%, with approximately 2/3 of the losses occurring between the water treatment plant and the storage reservoirs, and 1/3 of the losses occurring downstream of the storage reservoirs. Spreadsheet summaries for this analysis are provided in **Appendix F**. A summary of these results are provided in **Table 5-4**. It should be noted that the leak repairs completed by Public Works completed on the WTP Finished Water Line in late July 2013 are not reflected in this analysis.

Table 5 - 4 Carlton Water System Consumption and Loss Summary (MG)

	2010	2011	2012	Average	% of Total
Total Demand	119.00	120.49	113.54	117.68	
Consumption East of Storage Reservoirs (toward town)	67.88	67.34	69.55	68.26	58%
Loss East of Storage Reservoirs	14.33	17.08	16.20	15.87	13%
Consumption West of Storage Reservoirs (away from town)	3.11	2.82	2.46	2.80	2%
Loss West of Storage Reservoirs	33.68	33.26	25.33	30.76	26%

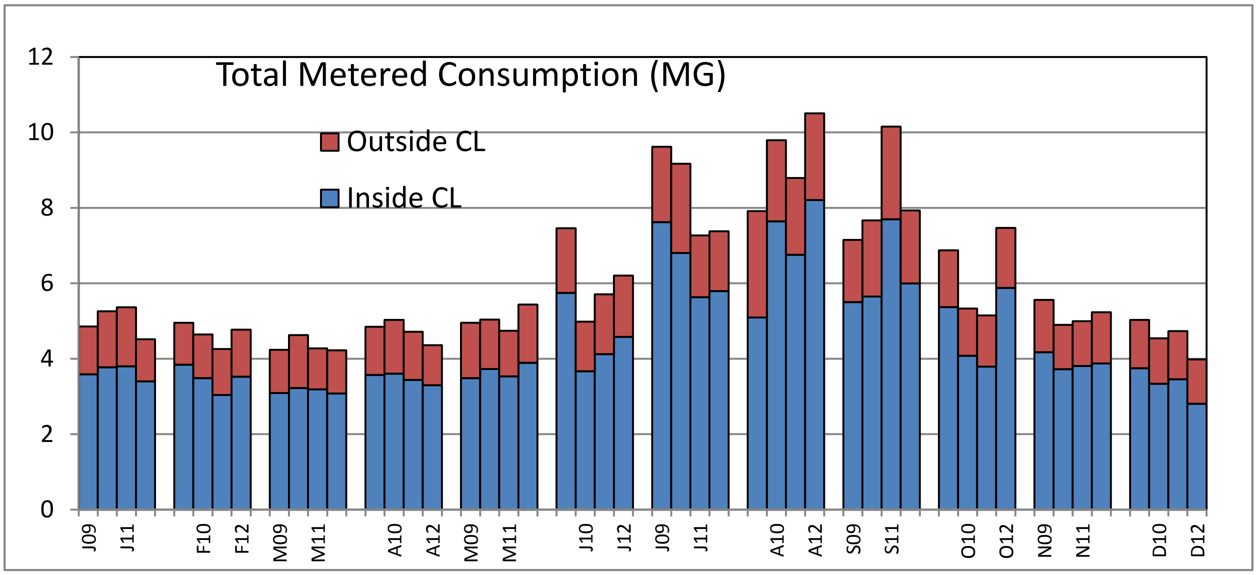
Of four general end uses for water produced at the water treatment plant (e.g., consumption outside the CL/UGB, loss outside the CL/UGB, consumption inside the CL/UGB, loss inside the CL/UGB) for, only the consumption inside the City Limits/UGB will be adjusted for population growth. Since new connections outside the City Limits/UGB are restricted to special circumstances, we have assumed that no new connections will be permitted and that current users will continue to use the same amount of water. With regard to losses, whether inside or outside the City Limits/UGB, the current losses are noticeably higher than typical. As such, ongoing measures should be occurring to keep losses from increasing. At the same time, given the age of the various pipes both inside and outside the City Limits/UGB, there is a significant likelihood that new leaks will occur periodically, offsetting efforts at overall leak reduction.

The above analysis focused on tracking water throughout the system. One of its values for this study is the finding that total system losses are on the order of 40% of Demand. For simplicity that 40% is going to be assumed to be equally divided between losses inside the City Limits/UGB and outside the City Limits UGB. The remaining portion of demand consists of consumption. Consumption data was obtained from City water billing records, with data summarized for the years 2009-2012 in **Table 5-5**, with the basic data presented graphically in **Figure 5-5**.

Table 5 - 5 Carlton Water System Consumption Summary (MG)

	2009	2010	2011	2012	Average	% of Total Consumption	% of Total Demand
Inside CL/UGB	54.83	52.72	52.27	54.33	53.54	75%	45%
Outside CL/UGB	18.62	18.27	17.89	17.68	18.11	25%	15%
Total	73.45	70.99	70.15	72.01	71.65		
% of Total Demand Assumes Total Consumption is 60% of Total Demand (40% is Loss)							

Figure 5-5 Total Metered Consumption 2009-2012 (MG)



The net result of the above discussion results in an Average Day Demand of 160 gpcd (rounded up from 158 gpcd), 72 gpcd (45% of current values) of which will be adjusted for population growth and 88 gpcd (55% of current values) of which will be held steady over time when calculating future demands.

5.4.3 Peaking Factors

Having established a per capita Average Day Demand the next step is to develop values for the peaking factors of Maximum Month Demand (MMD) and Maximum Day Demand (MDD). Because losses are assumed to be steady both from month to month and from year to year, peaking factors are applied to consumption followed by adding losses to calculate Demand. Calculations for MMD and MDD will be presented in the following sections.

5.4.4 Maximum Month Demand (MMD)

As just mentioned, MMD will be developed using peaking factors applied to Consumption, then the steady losses will be added to calculate the total MDD. Since Consumption varies more inside the City Limits/UGB, two separate peaking factor calculations will be performed.

Table 5-6 summarizes the MMD peaking factor calculations for inside the City Limits/UGB while **Table 5-7** summarizes the MMD peaking factor calculations for outside the City Limits/UGB.

Table 5-6 MMD Historical Peaking Factor for Consumption Inside the City Limits/UGB

	2010 (MG)	2011 (MG)	2012 (MG)	Average (MG)	Average (MGD)	Average (gpm)
Average Month	4.39	4.36	4.53	4.43	0.143	99
Maximum Month	7.64	7.70	8.21	7.85	0.253	176
Peaking Factor	1.74	1.77	1.81	1.77		

Table 5-7 MMD Historical Peaking Factor for Consumption Outside the City Limits/UGB

	2010 (MG)	2011 (MG)	2012 (MG)	Average (MG)	Average (MGD)	Average (gpm)
Average Month	1.52	1.49	1.47	1.50	0.048	33
Maximum Month	2.15	2.03	2.30	2.16	0.070	48
Peaking Factor	1.41	1.36	1.56	1.45		

Based on these calculations a MMD Peaking Factor of 1.77 will be used for Consumption inside the City Limits/UGB and a MMD Peaking Factor of 1.45 will be used for Consumption outside the City Limits/UGB for calculating Maximum Month Demand. Maximum month demand is perhaps the most variable of the peaking factors, as the period is long enough to capture the full effect of seasonal weather trends.

5.4.5 Maximum Day Demand (MDD)

MDD is traditionally defined as the highest production day during the year. MDD values are conventionally utilized to size treatment plant capacity, large diameter transmission mains and factor into the sizing of reservoirs. MDD is typically the most critical water demand scenario and is usually the standard by which system adequacy and access to water supply (water rights) is measured. As with MMD, separate peaking factors will be used for Consumption inside the City Limits/UGB and Consumption outside the City Limits/UGB, and losses will assumed to be unchanging. Maximum Day Demand data was taken from water treatment plant logs for the following dates: July 25, 2010, August 11, 2011, and August 16, 2012 (Values listed are Total Filtered – Total Backwash – Misc. Uses).

Table 5-8 summarizes the MDD peaking factor calculations for inside the City Limits/UGB while **Table 5-9** summarizes the MDD peaking factor calculations for outside the City Limits/UGB.

Table 5-8 MDD Peaking Factor for Consumption Inside the City Limits/UGB

	2010 (MGD)	2011 (MGD)	2012 (MGD)	Average (MGD)
Average Day Demand	0.327	0.330	0.311	0.323
Inside CL/UGB Consumption*	0.144	0.142	0.149	0.145
Maximum Day Demand	0.527	0.655	0.561	0.581
Inside CL/UGB Consumption*	0.245	0.309	0.345	0.299
Peaking Factor	1.70	2.17	2.31	2.061
*ADD Inside CL/UGB Consumption calculated from full year ratios of total consumption inside the CL/UGB vs. total demand. MDD Inside CL/UGB calculated from Maximum Month ratios for total consumption inside the CL/UGB vs. total demand for the month in which the maximum day occurred.				

Table 5-9 MDD Peaking Factor for Consumption Outside the City Limits/UGB

	2010 (MGD)	2011 (MGD)	2012 (MGD)	Average (MGD)
Average Day Demand	0.327	0.330	0.311	0.323
Outside CL/UGB Consumption*	0.049	0.050	0.047	0.048
Maximum Day Demand	0.527	0.655	0.561	0.581
Outside CL/UGB Consumption*	0.085	0.093	0.097	0.092
Peaking Factor	1.74	1.88	2.07	1.893
*ADD Outside CL/UGB Consumption calculated from full year ratios of total consumption Outside the CL/UGB vs. total demand. MDD Outside CL/UGB calculated from Maximum Month ratios for total consumption Outside the CL/UGB vs. total demand for the month in which the maximum day occurred.				

Based on these calculations a MDD Peaking Factor of 2.06 will be used for Consumption inside the City Limits/UGB and a MDD Peaking Factor of 1.89 will be used for Consumption outside the City Limits/UGB.

5.4.6 Peak Hour Demand (PHD)

Due the short duration of peak hour demand and the large cost of constructing source and treatment facilities to match this demand, peak hour demand (unlike maximum day demand) is satisfied with reservoir storage. The distribution network must be capable of supplying peak hour demand with a minimum residual pressure of 20 psi throughout the system.

The City does not currently collect demand data on an hourly basis. Therefore, in order to estimate and project the peak hour demand, a peaking factor is needed. Because of the conservatism typically utilized at the master planning level, an ADD:PHD peaking factor of 5.0 was selected and will applied to both consumption inside and outside the City Limits/UGB for PHD calculations throughout this report. No peaking factor will be applied to losses while calculating PHD.

5.4.7 Water Loss

Water loss or unaccounted-for water is comprised of the difference between the finished water produced and the water consumed, and consists of all unmetered uses and system leakage. It is important to differentiate these two categories of water loss.

Unmetered use is commonly the result of incomplete or inaccurate metering of consumer demand, including the following typical categories.

- Unmetered or unauthorized connections
- Inaccurate or unrecorded flows for hydrant and main flushing
- Inaccurate water meters (meters tend to under record as they age)
- Unmetered water for construction activities
- Unmetered water for operations & maintenance uses (street cleaning)
- Unmetered water for fire fighting
- Reservoir overflows
- Data collection errors

System leakage, as the name implies, is water lost due to deteriorating pipe, compromised pipe joints, service connections, valves, etc. With proper record keeping and metering of water, the percentage of unaccounted-for water approaches the net volume lost to actual leakage. Conventionally acceptable rates of water loss range between 10 and 15 percent, although water loss for many small Oregon municipalities is around 20%.

The Oregon Water Resources Department's Administrative rules governing Water Management and Conservation Plans (WMCP) requires municipalities to conduct annual water audits (See OAR 690-086-0150(4)(a)). Consistent with the City's WMCP being developed in coordination with this plan, we recommend that the City conduct these water audits at least annually. After each water line replacement project, the City should monitor the decrease in system loss thru the water loss audits.

As discussed above, in order to develop a comprehensive picture of where the treated water was going once it entered the transmission main, the system was evaluated in two parts with the 1 MG steel storage reservoir as the dividing line. This location was chosen because of the water meter installed downstream of this reservoir that measures flow leaving the reservoir on its way to town. The total annual losses were found to be approximately 40% of Demand, divided roughly equally east and west of the 1 MG steel storage reservoir.

Water Loss West of the Storage Reservoirs (toward the Water Treatment Plant)

The Finished Water Transmission Line from the water treatment plant to the 1 MG steel storage reservoir is nearly 7 miles long. The large majority of this line is 12-inch steel that was installed in 1967. Outside of the 12-inch steel, the first 3/4-mile segment downstream of the WTP is 10-inch steel and the segment between the concrete storage reservoir and the steel storage reservoir is 10-inch cast iron in Meadow Lake Road and 16-inch Ductile Iron in the access driveway to the steel storage reservoir.

There are approximately 33 services in this section, and a few valves and other components such as ARVs. This leaves long distances between points where a surface contact can be made directly to the waterline, which is the method used to use acoustic equipment to located and estimate the magnitude of leaks.

Because leak detection for this area is difficult, it is not surprising that the March 2013 leak detection study only identified leaks estimated in the 1/4-1/2 MG per year range, while the water balance calculations estimate leaks in the same area to be in the 20-28 MG per year range.

Water Loss East of the Storage Reservoirs (toward town)

In marked contrast to the small proportion of leaks identified west of the 1 MG steel storage reservoir, the calculations appear to indicate that the percentage of leaks east of the reservoir is fairly high. East of the 1 MG steel storage reservoir the March 2012 leak study estimate leaks in the range of 12-20 MG. These numbers compare well with the annual losses of 15-20 MG estimated by the water balance analysis.

Furthermore, a significant portion of these leaks are concentrated in just a few larger leaks. A total of five leaks are estimated to account for approximately 11-17 MG of the 15-20 MG total. This appears to provide a good opportunity for significant leak reduction, likely with a relatively small cost. At the same time, given the age of certain portions of the transmission and distribution system east of the 1 MG water reservoir, new leaks should be expected, resulting in ongoing issues for at least the near term until the older waterlines can be replaced.

5.4.8 Water Users by Category

Water consumption by use category was determined by reviewing available water-billing records for 2012. A summary of the current water users is contained in **Tables 5-10** for users inside the City Limits/UGB and **Table 5-11** for users outside the City Limits/UGB. Within these rate codes there is no distinction between residential users and other users such as commercial or industrial. Where such data is available it is sometimes used to project different uses at different growth rates and/or peaking factors. For this study this information is included here for general information purposes. No further reference is made with regard to calculations or projections. Detailed use by code is included in **Appendix G.**

Table 5-10 Water User Summary – Inside City Limits/UGB Users

User Classification (Rate Code)		# of Accounts
Single	(Rate Code1)	764
Double	(Rate Code 4)	10
Triple	(Rate Code 5)	1
Quad	(Rate Code 6)	1
"15"	(Rate Code 8, Carlton Apartments)	
"38"	(Rate Code 10, Carlton Oaks MHP)	1
"Seven"	(Rate Code 17)	3
"17"	(Rate Code 19, Elementary School)	1
Public	(Rate Code 20)	6
	Inside City Limits/UGB Total	788

Table 5-11 Water User Summary – Outside City Limits/UGB Users

User Classification (Rate Code)	# of Accounts
Single (Rate Code 2)	99
(Rate Code 9)	1
Double (Rate Code 15)	1
Valley View Water District	1
Triple (Rate Code 18)	1
Outside City Limits/UGB Total	103

5.5 PROJECTED WATER DEMAND

This section builds on the discussions of population projections in Section 5.3 and the discussion of historical water demand as presented in Section 5.4. The basis for projecting future water demands is based in the establishment of a historical demand baseline along with historical peaking factors. The population projections of Section 5.3 will be combined with historical per capita usage rates and peaking factors established in Section 5.4 to forecast future water demands.

5.5.1 Projected Municipal Water Demand

Projected municipal demands have been based on the following assumptions:

- It is assumed that the ratio of residential to non-residential use (commercial, industrial and public uses) will remain constant. In other words, future commercial and industrial developments will track population growth.

- It is assumed that the long-term per capita water demands will not exceed the City's historical averages. Since the efficacy of planned water conservation programs is unknown at this time, the water demand projections of this report exclude conservation. The future success of the City's water conservation policies will serve to further increase the margins of safety used to plan and design the water system infrastructure.
- It is assumed that new commercial and industrial developments will not be large water users; no provision has been made for new industries with heavy water demands such as food processing or beverage production.
- It is assumed that the population projections of Section 5.3 are reasonable estimates of future municipal populations and that the forecasted peaking factors established in Section 5.4 are reasonable estimates of future demand variations.
- It assumes that future water loss will not exceed the City's historical averages. The goal is for losses to actually decline over time as older pipe segments are replaced with new pipe, but given the extent of older pipe in the system we anticipate some time may pass before consistent loss reduction is realized.

5.5.2 Projected Water Demand Summary

Future water demand for the municipal population is calculated by adding the current demand to the product of the per-capita demand values times the projected additional population for the planning year in question.

Table 5-12 summarizes the Average Day Demand, **Table 5-13** summarizes the Maximum Month Demand, **Table 5-14** summarizes the Maximum Day Demand and **Table 5-15** summarizes the Peak Hour Demand for the study period.

Table 5-12 Average Day Demand Through 2033

Year	2012	2015	2020	2025	2030	2033
Population	2065	2080	2247	2465	2669	2801
Consumption Inside CL/UGB (MGD)	0.149	0.150	0.162	0.177	0.192	0.202
Consumption Outside CL/UGB (MGD)	0.050	0.050	0.050	0.050	0.050	0.050
Total Losses (MGD)	0.132	0.132	0.132	0.132	0.132	0.132
Total ADD (MGD)	0.331	0.332	0.344	0.359	0.374	0.384
Total ADD (gpm)	230	230	239	250	260	266

Table 5-13 Maximum Month Demand Through 2033

Year	2012	2015	2020	2025	2030	2033
Population	2065	2080	2247	2465	2669	2801
Consumption Inside CL/UGB (MGD)	0.263	0.265	0.286	0.314	0.340	0.357
Consumption Outside CL/UGB (MGD)	0.073	0.073	0.073	0.073	0.073	0.073
Total Losses (MGD)	0.132	0.132	0.132	0.132	0.132	0.132
Total MMD (MGD)	0.468	0.470	0.491	0.519	0.545	0.561
Total MMD (gpm)	325	326	341	360	378	390

Table 5-14 Maximum Day Demand Through 2033

Year	2012	2015	2020	2025	2030	2033
Population	2065	2080	2247	2465	2669	2801
Consumption Inside CL/UGB (MGD)	0.306	0.309	0.333	0.366	0.396	0.415
Consumption Outside CL/UGB (MGD)	0.095	0.095	0.095	0.095	0.095	0.095
Total Losses (MGD)	0.132	0.132	0.132	0.132	0.132	0.132
Total MDD (MGD)	0.533	0.535	0.560	0.592	0.622	0.642
Total MDD (gpm)	370	372	389	411	432	446

Table 5-15 Peak Hour Demand Through 2033

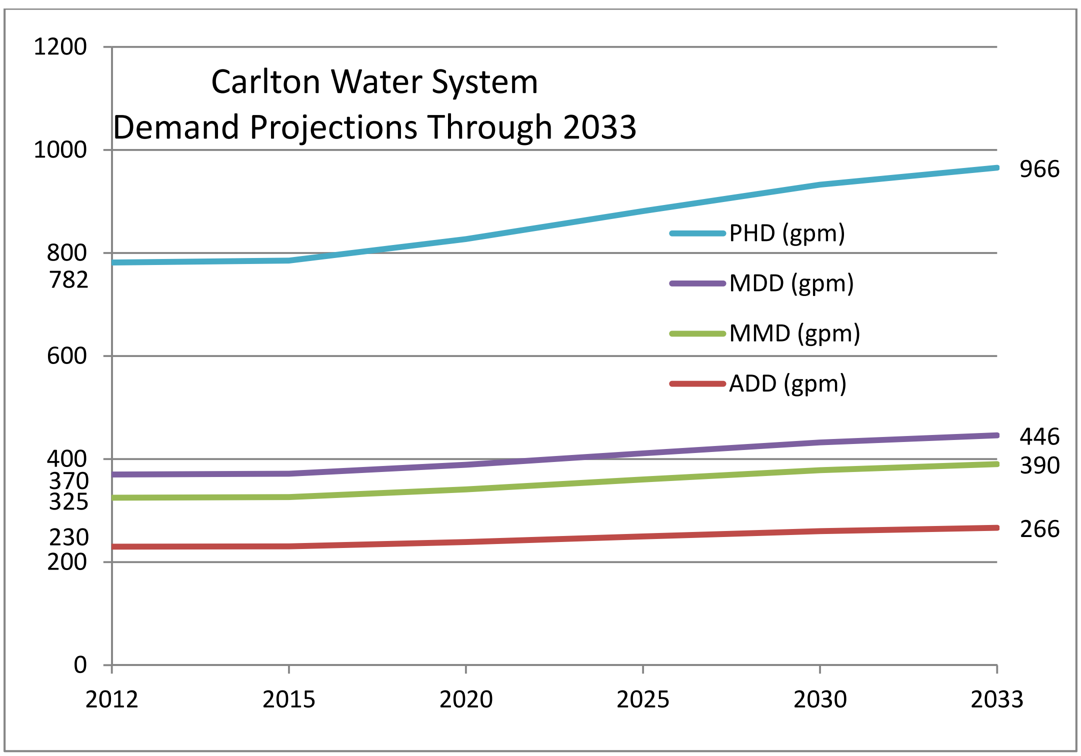
Year	2012	2015	2020	2025	2030	2033
Population	2065	2080	2247	2465	2669	2801
Consumption Inside CL/UGB (MGD)	0.743	0.749	0.809	0.887	0.961	1.008
Consumption Outside CL/UGB (MGD)	0.250	0.250	0.250	0.250	0.250	0.250
Total Losses (MGD)	0.132	0.132	0.132	0.132	0.132	0.132
Total PHD (gpm)	782	785	827	882	933	966

These results from **Tables 5-12** through **5-15** are summarized in **Table 5-16** and illustrated in **Figure 5-6** below.

Table 5-16 Summary of Projected Water Demands

Year	2012	2015	2020	2025	2030	2033
Population	2065	2080	2247	2465	2669	2801
Avg. Day Demand (ADD)						
MGD	0.331	0.332	0.344	0.359	0.374	0.384
(gpm)	230	230	239	250	260	266
Max. Month Demand (MMD)						
MGD	0.468	0.470	0.491	0.519	0.545	0.561
(gpm)	325	326	341	360	378	390
Max. Day Demand (MDD)						
MGD	0.533	0.535	0.560	0.592	0.622	0.642
(gpm)	370	372	389	411	432	446
Peak Hour Demand (PHD)						
(gpm)	782	785	827	882	933	966

Figure 5-6 Projected Average Day Demand and Maximum Day Demand



Maximum daily demands have special significance because they can put stress on the water supply capabilities of the system. The water system should be able to supply the entire water demand during the maximum day of the year in addition to any required fire flows.

5.6 FIRE FLOWS

The water distribution system is a community's primary resource for fighting fires. Storage facilities and fire hydrants must be suitably sized and configured to reliably deliver the required fire flows to all areas within the city limits. The Insurance Services Office (ISO) and Oregon Fire Code (OFC) provide guidelines to determine fire flows for various structures.

The ISO standards require a minimum flow of 1,000 gpm for a 2 hour duration in residential areas and a flow of 3,500 gpm for a 3 hour duration in commercial areas. The OFC recommends fire flows based in part on an evaluation of the construction materials used in a structure, its physical configuration, separation from other structures and occupancy. On this basis, fire flows for large commercial, industrial and multi-family developments may be higher than 3,500 gpm, unless fire sprinkler systems are provided.

The City has adopted a policy of requiring adequate fire flow capacity as a prerequisite for the purposes of planning for future development, and plans to codify the fire flow requirements in the PWDS. This information is summarized in **Table 5-19**.

Table 5-17 Minimum Fire Flow Requirements

Location	Recommended Fire Flow (gpm)	Duration (hours)	Required Volume (gallons)
Residential Low Density, R-1	1,000	2	120,000
Residential Medium Density, R-2	1,500	2	180,000
Residential Med.-High Density, R-3	2,000	2	240,000
Manufactured Home (MH)	2,000	2	240,000
Mixed Density Residential (MX)	2,000	2	240,000
Downtown District (D)	3,500	3	630,000
Commercial Business (CB)	3,500	3	630,000
Commercial Industrial (CI)	3,500	3	630,000
General Industrial (IG)	3,500	3	630,000
Public Facility (PF)	3,500	3	630,000

These fire flow values are for planning purposes only, and are not site or building specific. These values do not supersede or take the place of Oregon Fire Code (OFC) or building code fire flow requirements. Higher values may be necessary based on OFC, Fire Marshall or ISO requirements. Reductions may be allowed by the Fire Chief for buildings with fire sprinkler systems.

It should be noted that these minimum recommendations do not supersede fire flows required by the Oregon Fire Code or building codes.

Fire flows, in general, are orders of magnitude greater than MDD or PHD flows. In order to limit the size of water mains delivering fire flows to large combustible structures and the overall volume of water required to suppress a fire, some cities have adopted policies stating that all buildings requiring fire flows greater than 2,500 gpm must install an automatic sprinkler system.

In September 2008, the International Residential Fire Code Fire Sprinkler Coalition, a U.S. association comprised of more than one hundred fire service, building code official, and safety organizations representing 45 states, voted unanimously to modify the International Residential Code (IRC) and require sprinkler systems for all new one- and two-family homes and townhouses. The change first appeared in the 2009 IRC. Forty-six states (including Oregon) use the IRC as the model document for their codes regulating new home construction. Future announcements will determine an implementation schedule for this trend in residential fire protection.

Lastly, in addition to the required flow rates presented above, OAR 333-061-0025 requires that a minimum pressure of 20 psi must be maintained in the distribution system at all times, inclusive of fire flow events. Evaluations of the distribution system (existing and future) to deliver the adopted fire flows are presented in Chapter 8 of this report.

CHAPTER 6

WATER SUPPLY EVALUATION

Chapter Outline

WATER SUPPLY (SOURCE) EVALUATION

CHAPTER 6

6.1 INTRODUCTION

The first element in providing a community with the water it needs is a source (or sources of supply). Two separate issues must be addressed in order for a source to be used and relied upon.

- The legal right to appropriate the water for the community's use.
- Water reliably available in sufficient quantity and quality combined with the infrastructure necessary to get that water to the water treatment plant.

For the purposes of this report the source of supply is addressed separately from the remainder of the City's water system which includes the water treatment plant, storage reservoirs, and transmission and distribution system.

This chapter discusses the City's water sources, presents the regulatory framework for water rights and details the water rights secured by the City to date. It also addresses the various issues relating to the sufficiency and reliability of the water supply and infrastructure upstream of the water treatment plant. It concludes with recommendations regarding the City's water rights and improving the overall water supply system.

Recommended budget numbers to cover the capital costs for the recommendations presented in this chapter appear in Chapter 12.

6.2 EVALUATION CRITERIA

Factors used to evaluate the suitability of existing and planned water supplies include legal authority, along with reliability and resiliency. A short explanation of each of these evaluation criteria is presented below. The parameters presented in this section will be used in the analysis and recommendations of this chapter.

6.2.1 Water Rights

Under Oregon water law, with few exceptions, the use of public water (both ground and surface water) requires a Water Right Permit from the Oregon Water Resources Department (OWRD). The right to use water is typically first granted in the form of a water use permit. The permit describes the priority date, the amount of water that can be used, the location and type of water use and often a number of water use conditions. The permit allows the water user to develop the infrastructure needed to put the water to full beneficial use – a requirement of Oregon water law. A water right is not a guarantee that water will be available. Water may not be available due to limitations on the source, regulation due to senior users, or due to conditions on the water rights.

When the report of beneficial use, called a Claim of Beneficial Use (COBU), is approved by OWRD, a Water Right Certificate is issued confirming the status of the right. Generally, a COBU establishes the maximum extent of beneficial use. In the case where multiple water rights are diverted at the same point of diversion, the COBU must take into account existing certificated water rights and the physical capacity (water treatment plant, etc.) to beneficially use all of the water rights at that location. Holders of municipal water rights can partially certificate, or partially perfect, a permit so long as the partial certificate is not less than 25 percent of the quantity originally authorized by permit. Obtaining a water right certificate is the best way to ensure the protection of the use since municipal water use certificates are generally not subject to cancellation due to non-use and are not subject to legislative and administrative changes affecting undeveloped uses.

Water right permits typically have timelines for making full beneficial use of the water. If more time is needed than provided in the permit, the permit holder may request an "extension of time" from OWRD. In the past, extensions of time were routinely granted by OWRD. Under current rules, an extension of time may involve an analysis of what would happen to state and federally listed fish species if the "undeveloped portion of the permit" were to be used.

6.2.2 Reliability and Resiliency of Water Sources

In general, reliability is a measure of how likely the system is to fail and how severe the consequences of failure may be, and resiliency is a measure of how quickly it can recover from a failure Consideration of these criteria can assist in the evaluation and selection of design or operating alternatives.

6.2.2.1 Water Source Reliability

There are two main reliability factors to be evaluated when considering water sources:

- the reliability of the water sources to produce water in sufficient quantity and quality
- the reliability of the infrastructure used to get the water to the water treatment plant

The City's water source system (sources as a whole) can be considered to have failed when they cannot meet the demands placed on the water system by the users. A particular water source (individually) can be considered to have failed when that source is not able to provide water to the system.

The following goals are considered desirable when working toward the development of a high level of reliability for the water source system as a whole:

- Two or more sources of water supply developed with a capacity to replenish depleted fire suppression storage within a 72-hour period while concurrently supplying MDD.
- When the largest single source is out of service, the remaining sources should be able to satisfy ADD.

6.2.2.2 Water Source Resiliency

As noted above, source resiliency is a measure of how quickly a source can recover from a failure. Resiliency also needs to be evaluated with regard to both the water source(s) and with the infrastructure used to get the water to the water treatment plant.

6.3 WATER SOURCE EVALUATION

The City currently obtains all of its domestic water supply from the Carlton Reservoir impoundment on Panther Creek. The City also has undeveloped water rights on Fall Creek and on the Willamette River as part of the Yamhill Regional Water Authority. A detailed summary of these sources was presented in Chapter 4.

6.3.1 City of Carlton Water Rights

A summary of the City's existing water rights is contained in Section 4.3.1. The City currently holds water right certificates to store up to 75 acre-feet in Panther Creek (Carlton) Reservoir, to use the 75 acre-feet of stored water, and for the use of Panther Creek "natural streamflow." The City also holds water use permits for natural streamflow on Panther Creek, Fall Creek, and the Willamette River.

6.3.2 Water Rights Strategy

Because of the mix of certificated and permitted water rights on a variety of sources, several of which are currently undeveloped, further complicated by the differences between natural streamflow, storage and use of stored water water rights, evaluating Carlton's water rights situation is quite complex. Before starting into the analysis of the existing water rights it will be useful to mention that maximizing the use of the existing water rights is critical because of the difficulty involved with obtaining new water rights. Generally speaking, except for the Willamette River main stem, OWRD has determined that surface water is not available for appropriation during the peak demand months. In addition the use of groundwater in hydraulic connection to surface water is under the same limitations. Finally, the area surrounding Carlton is not a productive groundwater aquifer and the likelihood of finding a productive well (and obtaining a permit from OWRD) is low.

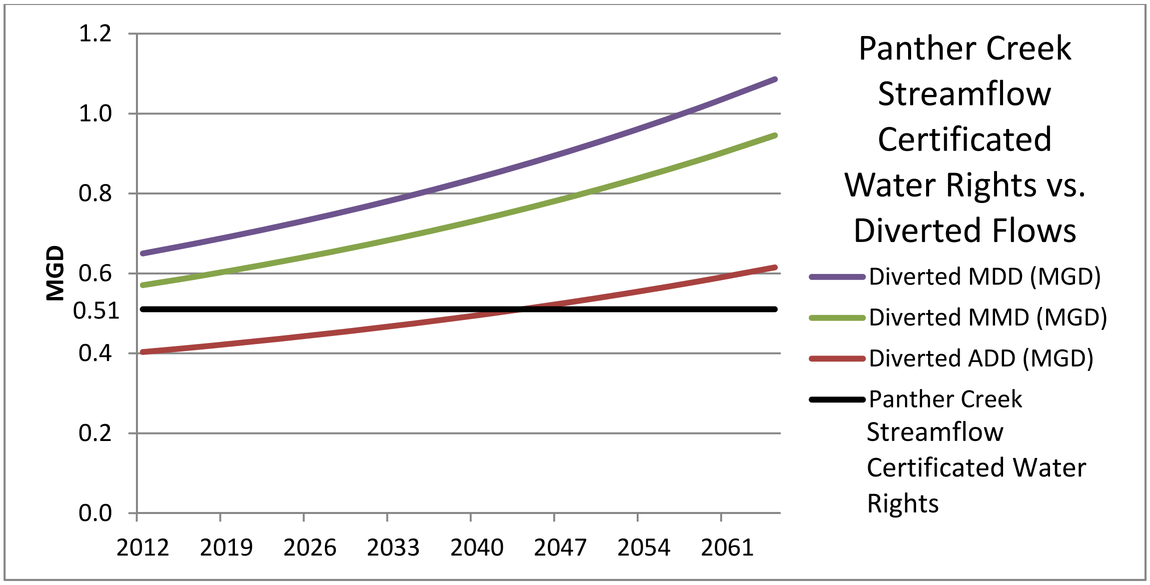
6.3.2.1 Panther Creek Water Rights

In order to provide a meaningful and understandable picture of Carlton's current water rights picture it will be helpful to start with a basic foundation and then add complexity in a step-by-step basis. In doing so this report will address the existing certificated rights for Panther Creek and Carlton Reservoir first, move to the permitted rights on Panther Creek and Carlton Reservoir, the finally include the permitted rights on Fall Creek and those for the Willamette River.

Because of the long term implication of water rights and the challenges related to acquiring additional supply, , this analysis will project well beyond the standard 20-year planning horizon out to the year 2065 (more than 50 years from now). The growth rate of 1.47% will continue to be used during this extended period. Understanding that changes are likely to occur during this lengthy period of time, these extended projections are provided solely for giving some sense of what various water rights scenarios might look like farther into the future than the standard planning period.

Carlton currently holds s certificated water rights totaling 0.789 cfs (354 gpm, 0.510 MGD) for the use of natural streamflow from Panther Creek plus the use of up to 75 acre-feet of stored water. . These certificated rights are compared against the various projected Diverted flows in **Figure 6-1**. Diverted flows differ from Demand discussed earlier because of water taken from the reservoir and used in water treatment plant operations that does not get delivered to the distribution system. Approximately 18% of the flow entering the water treatment plant goes to plant operations, thus Demand flows must be multiplied by 1.22 to calculate the Diverted flows.

Figure 6-1 Projected Diverted Flows vs. Panther Creek Certificated Water Rights



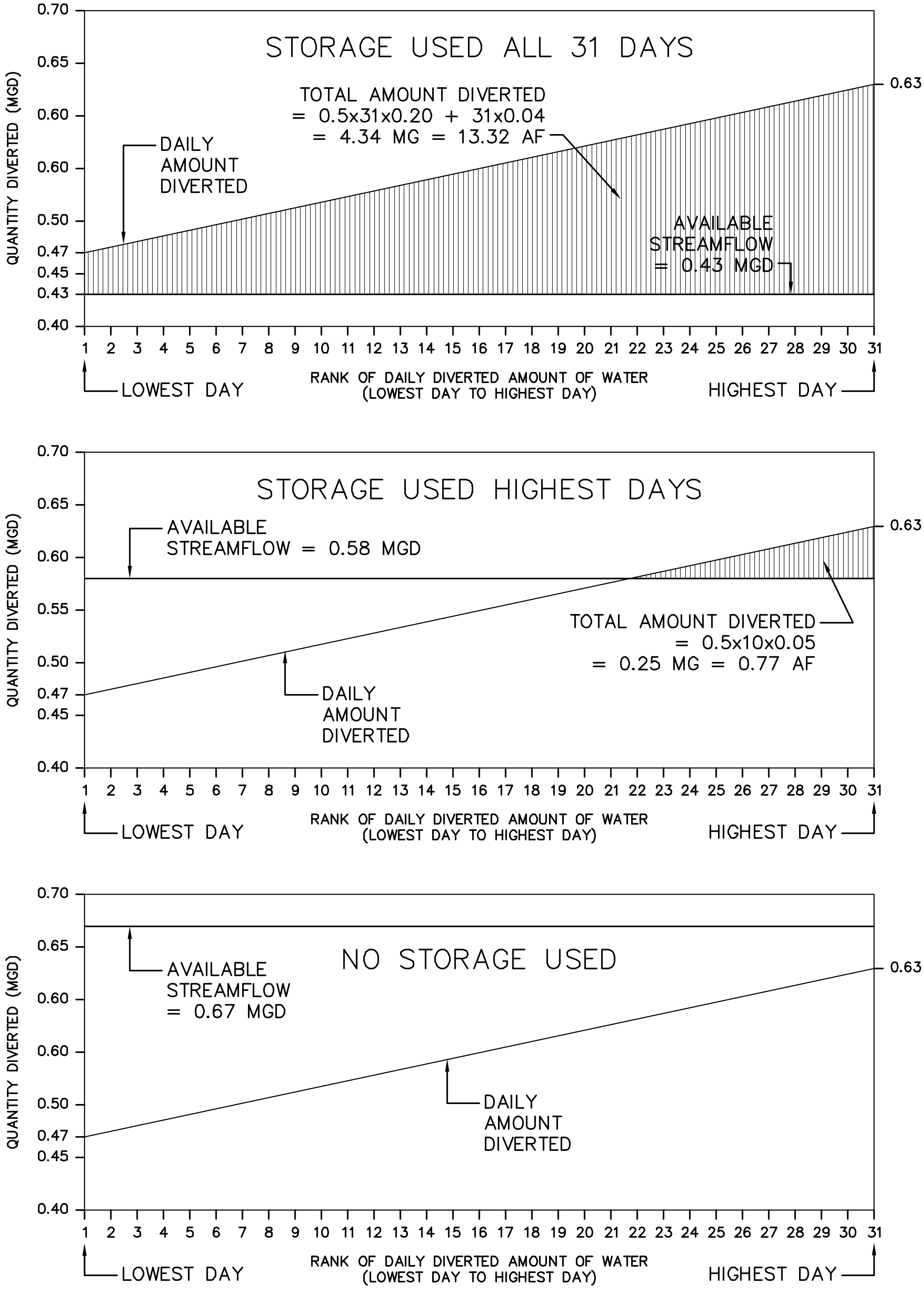
From **Figure 6-1** it is clear that the certificated water rights for Panther Creek (natural streamflow) alone are insufficient to meet anticipated demands. In fact, both Maximum Month Demand and Maximum Day Demand already exceed these water rights. At this point there are two reasonable next steps. One is to include the certificated storage rights on Carlton Reservoir, and the other is to include the permitted Panther Creek water rights. The use of these different water rights is not mutually exclusive. But, taking things one step at a time provides a clearer picture of the utility of each water right.

Continuing to review certificated water rights leads to looking at the Carlton Reservoir storage rights which total 75 acre feet. For our initial analysis we will assume that natural flow is available at an instantaneous rate of 0.789 cfs for 24 hours each day, equal to a total daily diversion of 0.510 MG. Using this assumption, each day the Diverted flow exceeds 0.510 MG, a deduction must be made from the 75 acre-feet of total storage water rights. The amount of the deduction is the amount by which the Diverted flow exceeded 0.510 MG.

(Note: The 0.789 cfs was selected because it equals the City's certificated water rights on Panther Creek, but the analysis is the same whether the streamflow limitation is due to water rights limitations or actual streamflow. It has already been stated that a water right does not guarantee that water will be available. In the following analysis should circumstances arise where natural streamflow is less than 0.789 cfs, a greater deduction from the storage right would occur?)

Figure 6-2 shows the methodology used to estimate the amount of stored water rights used for a given month. The starting point is to approximate the distribution of monthly total daily flows from the maximum day and maximum month values. The maximum day represents the highest day for the month and the maximum month represents the average day during that month. The day with the lowest total flow is assumed to be the same amount below average as the highest day is above average. The flow for the other days of the month is assumed to increment uniformly from the lowest day to the highest day, such that the second lowest day is equal to the lowest day plus $1/30^{th}$ of the difference between the lowest day and the highest day.

The amount of water taken from storage is the difference between the line representing estimated flows for each day of the month and the available water (whether limited by water rights or natural streamflow). When the available water is higher than the highest day’s demand for the month no water is withdrawn from storage. When the available water is less than the highest day’s demand for the month the amount of water withdrawn from storage is represented by the shaded area.



WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

SCALE
HORIZ: N/A
VERT: N/A

DSN. RCE
DRN. RCE
CKD. RCE
DATE: AUG 13

City of Carlton, Oregon

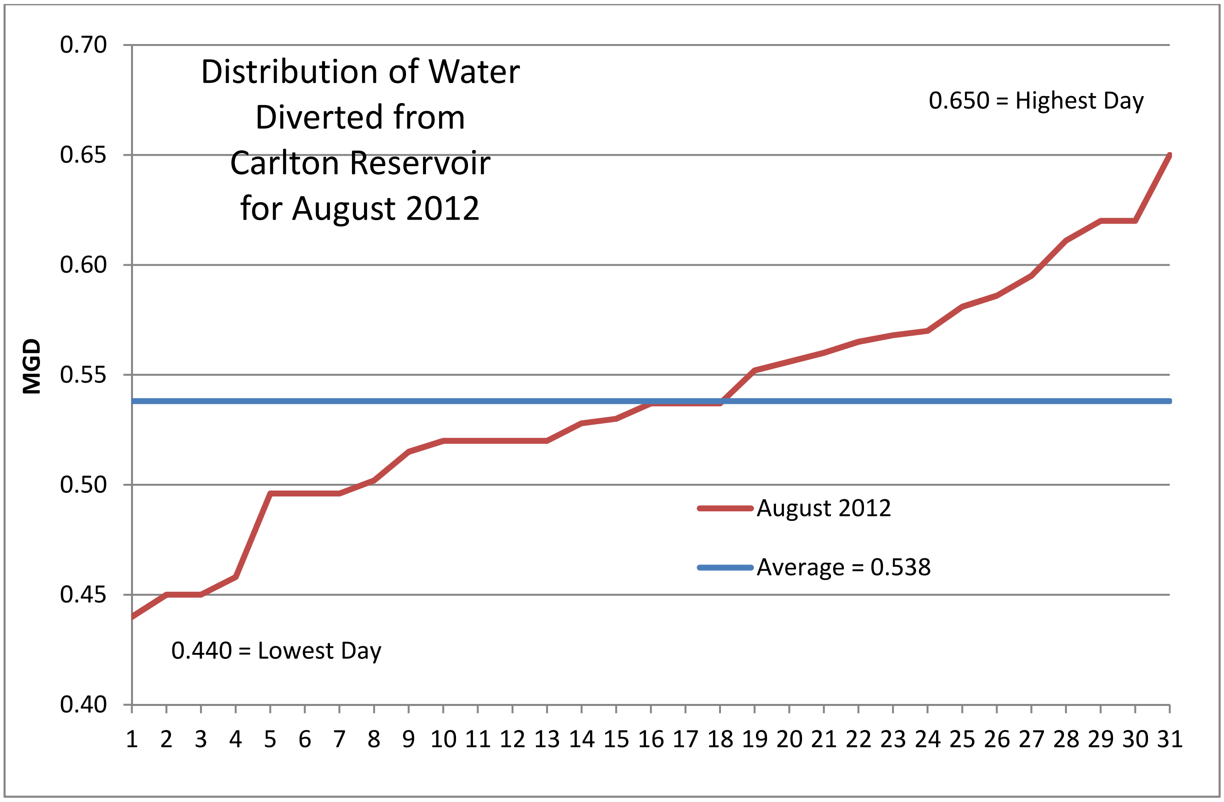
WATER RIGHTS STORAGE USED CALCULATION METHODOLOGY

FIGURE
6-2

JOB NUMBER
2674.0000.0

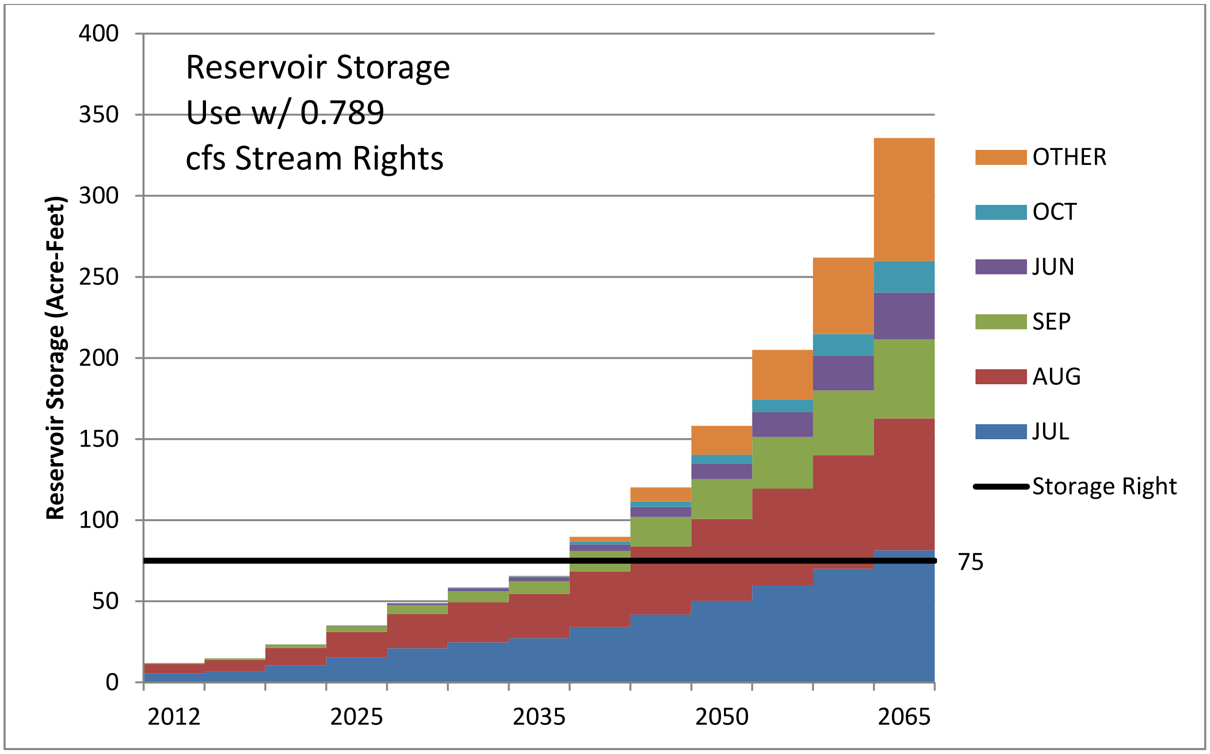
Figure 6-3 shows the recorded Diverted flows for August 2012 and is included to provide a sample by which to compare real data with the proposed model.

Figure 6-3 Diversion of Water from Carlton Reservoir, Lowest Day to Highest Day



Using the methodology and assumptions just described, **Figure 6-4** shows the amount of the 75 acre-feet of stored water rights that must be used to meet system demands assuming that only the certificated 0.789 cfs of natural flow on Panther Creek is considered (or the actual flow in Panther Creek is only 0.789 cfs). Note that the total storage water rights are not used until projected demand rises to the levels anticipated sometime between 2035 and 2040.

Figure 6-4 Carlton Reservoir Required Storage, Stream Flow Rights = 0.789 cfs



In order to show the effects of small increases in natural streamflow water rights (or actual increases in natural streamflow in a natural streamflow limited condition) on conserving storage the next step will just add the smallest permitted water right, 0.052 cfs, bringing the total natural streamflow water rights used in the calculations to 0.841 cfs. The results for this are shown in **Figure 6-5**. Under these conditions the City's 75 acre-feet of stored water is not used until projected demand rises to the levels anticipated sometime between 2040 and 2045.

If the 0.229 cfs permitted water right (Permit S-34661) is considered in the calculations along with the currently certificated 0.789 cfs rights the total available flow used in the calculation is 1.018 cfs. **Figure 6-6** shows these results and indicates that the City's stored water rights are not fully used until projected demand rises to the levels anticipated sometime between 2055 and 2060.

Finally, if all of the Panther Creek water rights reviewed so far in this section are added together the total is 1.070 cfs. The results for this scenario are presented in **Figure 6-7** where Storage Water Rights are not exceeded until projected demand rises to the levels anticipated sometime between 2060 and 2065, roughly 50 years from now.

Figure 6-5 Carlton Reservoir Required Storage, Stream Flow Rights = 0.841 cfs

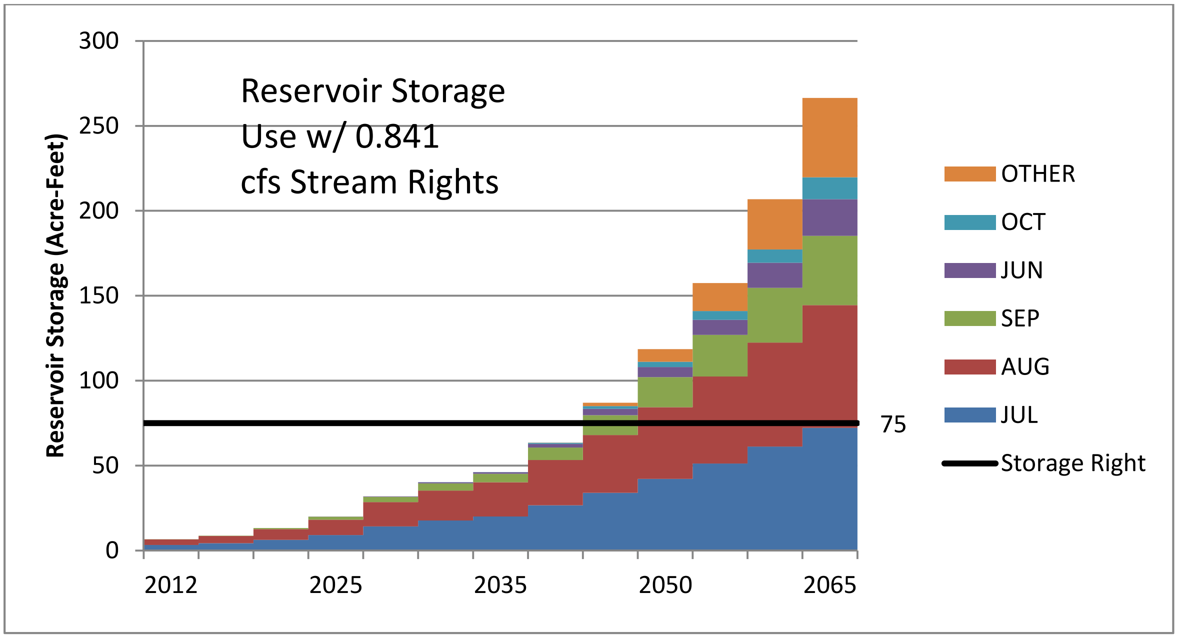


Figure 6-6 Carlton Reservoir Required Storage, Stream Flow Rights = 1.018 cfs

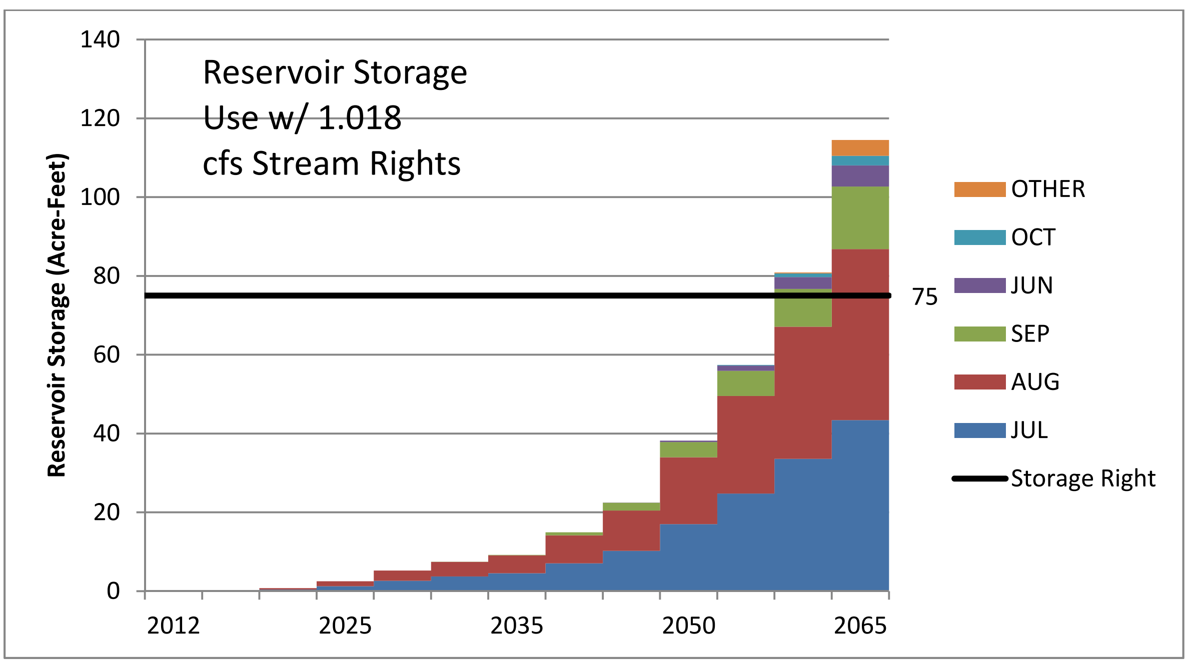
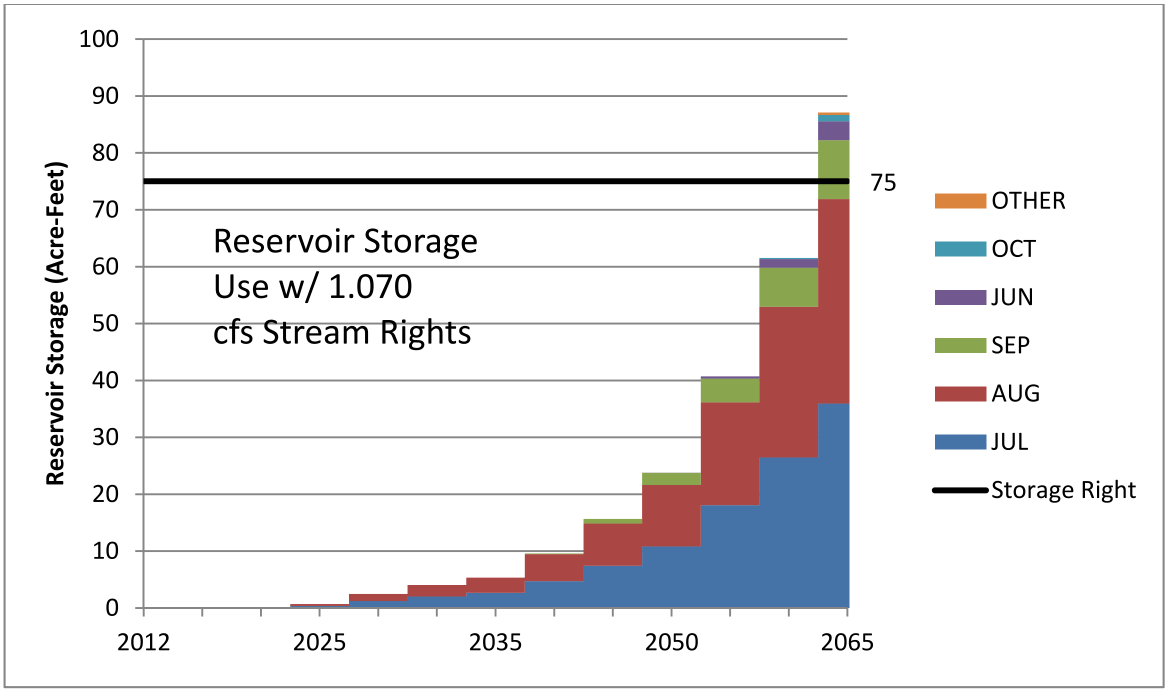
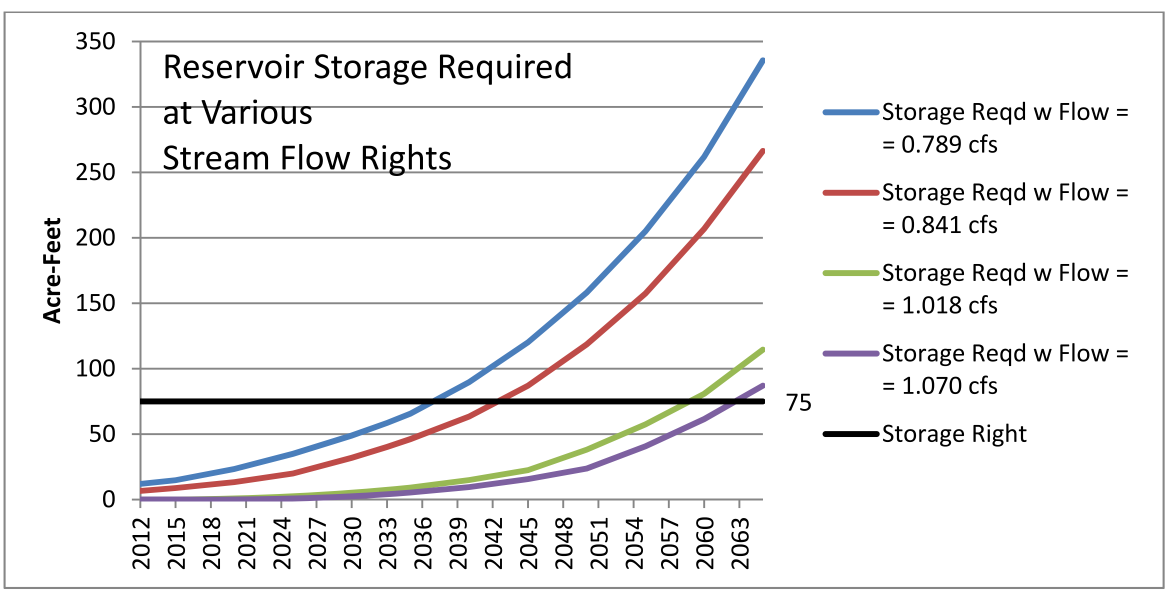


Figure 6-7 Carlton Reservoir Required Storage, Stream Flow Rights = 1.070 cfs



To complete the picture **Figure 6-8** compiles the totals for the four scenarios above into a single graph.

Figure 6-8 Carlton Reservoir Required Storage Summary



The City also has another 2.5 cfs of permitted water rights on Panther Creek (Permit S-32489). Given that increasing Panther Creek natural streamflow water rights from 0.789 cfs to 1.070 cfs (36% increase) has extended the sufficiency of the storage water rights from beyond 2035 to nearly 2065, it is evident that adding another 2.5 cfs of stream flow water rights would extend the sufficiency of the storage rights to well out into a relatively distant future.

As mentioned earlier, the smaller permitted natural stream flow water rights were used first in this analysis for illustrative purposes. The intent was to help the City gain a clearer picture of how natural stream flow water rights and storage water rights work together, and a sense of the importance of each existing water right, regardless of how small the quantity appears. Even the smallest increase in stream flow use extended the ability of the storage water rights to remain sufficient for about five years.

Before discussing specific issues regarding the Panther Creek natural stream flow water rights it is important to clarify that the City's water rights authorized by a permit (as compared to a certificate) are completely valid and usable, while they are in effect. The issue with permitted water rights is that they are subject to expiration unless they are certificated or receive an extension of time from OWRD. Currently, all of the City's water use permits, with the exception of the permit for use of the Willamette River, are in the permit extension process. Thus, it is in the City's interest to continue working toward certification of as much of the current permitted Panther Creek water rights as possible. We are aware that the City is currently doing just that and we concur with those efforts.

While a complete overview of all aspects of the ongoing Panther Creek water rights work is beyond the scope of this report, the following summary of information provided by the City's water rights consultants, GSI Water Solutions, is appropriate at this point.

Table 6-1 was developed by GSI Water Solutions outlining the current strategy with regard to certificating the City's Panther Creek water rights to the greatest extent possible. As mentioned above, certificating a water right requires a demonstration of the maximum beneficial use and must take into account other certificated water rights at the same point of diversion. For Carlton, the current limitation on maximum beneficial use is the capacity of the water treatment plant.

Table 6-1 Proposed Water Rights Permit Certification Strategy (from GSI)

App.	Permit	Cert.	Rate (cfs)	Source	Priority	Rate Perfected (cfs)		Rate Remaining (cfs)	*Allocated*
							Current WTP Capacity (cfs) =		2.979
S-1609	S-914	1868	0.5	Panther Cr.	8/12/1911	0.5	*Certificate dated 1/9/1918*	0	0.5
S-44208	S-32489	--	2.5	Panther Cr.	10/27/1967	0		2.5	2.190
S-46505	S-34661	86064	0.5	Panther Cr.	10/22/1969	0.271	*Certificate dated 2/2/2010*	0.229	0.271
S-69513	S-50218	86065	0.07	Panther Cr.	11/30/1987	0.018	*Certificate dated 2/9/2010*	0.052	0.018
Totals			3.57			0.789		2.781	2.979

In 2009 Carlton documented the water treatment plant capacity at 2.979 cfs for four continuous hours establishing the maximum rate of beneficial use of the City's natural flow water rights from Panther Creek. In other words, with the current infrastructure, this is the maximum rate of water right certificates the City can obtain from OWRD. . However, the combined total of permitted and certificated natural flow water rights is 3.57 cfs. The issue facing the City now is how best to pursue certificating the differences between the previously certificated 0.789 cfs and the maximum of 2.979 cfs. As indicated by **Table 6-1**, GSI is currently proposing that all of the difference be sought in the rights covered by Permit S-32489. This provides the oldest priority date and allows the amount to be obtained working with a single permit rather than multiple permits.

The one obstacle to this course of action is indicated in a footnote to **Table 4-2**. A permit extension was initially proposed for approval by OWRD but subsequently protested. The protest involves whether or not a review by the Oregon Department of Fish and Wildlife should occur. The question facing the City at this time is whether to litigate the protest or to accept the protest and allow the ODFW review, which will result in conditions on the permit and subsequent certificate affecting the future use of the right under certain low flow circumstances. **Appendix H** contains the proposed ODFW conditions for the extension for the 0.229 cfs under Permit S-34661, which GSI anticipates could be similar to those that could be attached to the 2.5 cfs Permit S-32489. However, if one assumes that the ODFW conditions are attached to Permit S-32489 and the "flow target is missed by 75% the City would still have approximately 1.34 cfs of certificated natural flow water rights available for use (the certificated water rights from Table 6-1 above and the 2.190 cfs under Permit S-32489 reduced by the 75% shortfall of the flow target).

Finally, it is important to note that all of the discussion above assumes that there will be sufficient natural streamflow in Panther Creek to allow the City to take full use of all of its various water rights. However, there is no data available on stream flow rates on Panther Creek above Carlton Reservoir. At this time the City, with GSI's assistance, is working to develop some preliminary information. . GSI has developed a measurement program that is designed to gather data from May through September. Generally it is desirable to have several years of this type of data when evaluating water rights opportunities. But, if the program is successful in collecting a sufficient quantity of good, reliable data this summer, it will be a significant improvement over the current situation.

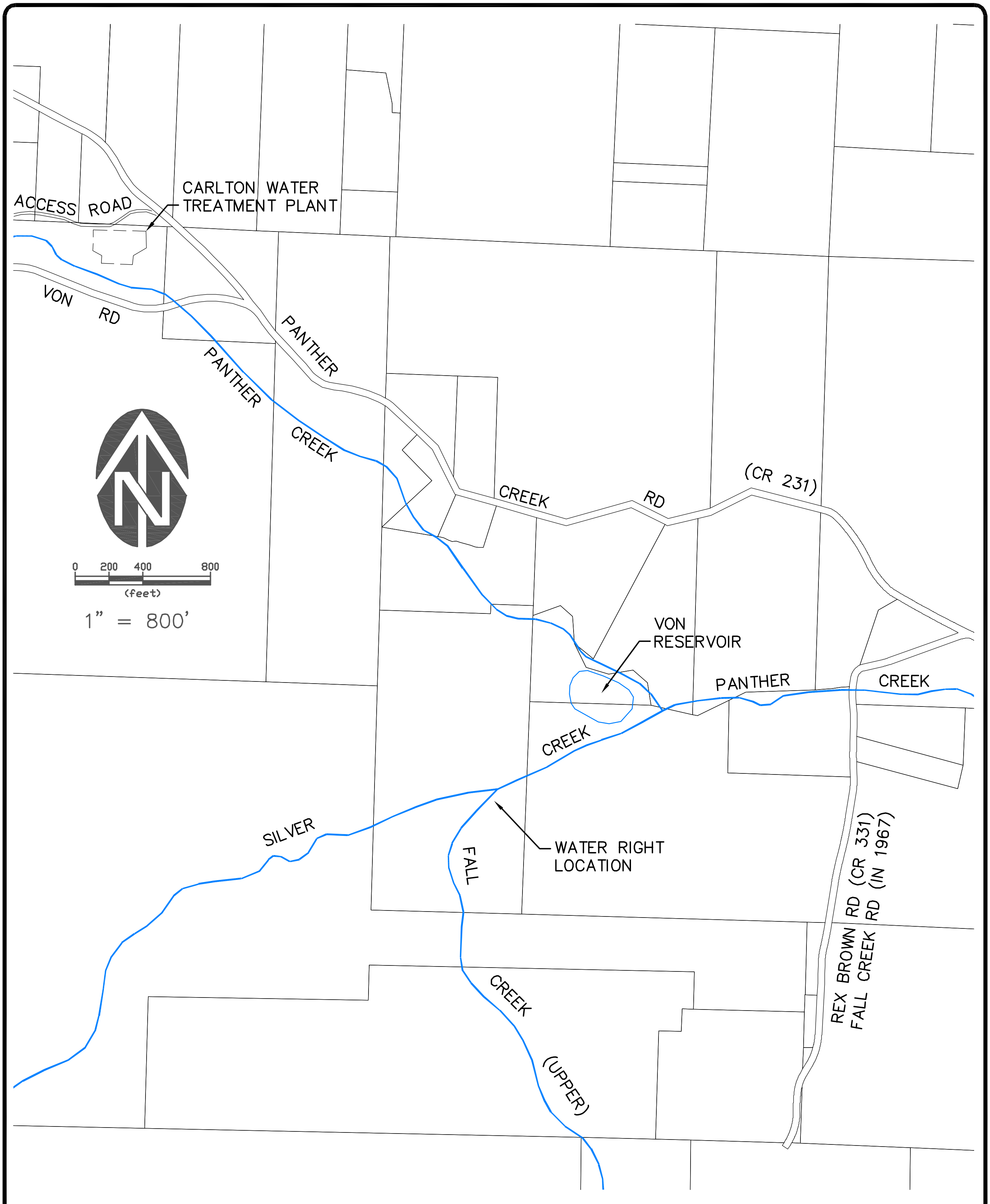
6.3.2.2 Other Current Water Rights

6.3.2.2.1 Fall Creek

As mentioned above and listed in **Table4-2**, the City has permitted water rights on Fall Creek.

It may be helpful here to clarify, that based on the point of diversion listed in the permit, that the Fall Creek involved is the first tributary to Panther Creek below the City's reservoir. actually "Falls" Creek, which is upstream of the Kane Creek junction with Panther Creek, rather the separate and distinct "Fall" Creek which is downstream of Kane Creek. A map showing the location of the relevant Fall(s) Creek is provided as **Figure 6-9.**

Because there is currently no infrastructure in place to allow the City to gain beneficial use of water from Fall(s) Creek, there is no basis for moving forward with certification for this right at this time. However, this right remains important and valuable to the City because it provides the opportunity for developing a second, independent source of supply as recommended by Section 6.2.2.1 above. For that reason, it is important that the City continue to take the appropriate steps to maintain this water right, including obtaining an extension of time, which we understand is now pending with OWRD.



WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

SCALE
HORIZ: N/A
VERT: N/A

DSN. RCE
DRN. RCE
CKD. RCE
DATE: AUG 13

City of Carlton, Oregon

FALL CREEK (UPPER) VICINITY MAP

FIGURE
6-9

JOB NUMBER
2674.0000.0

6.3.2.2.2 Willamette River, Yamhill Regional Water Authority

On January 17, 2013 OWRD issued Permit S-54792 assigning a municipal water right of 44.18 cfs from the Willamette River to the Yamhill Regional Water Authority. Based on an intergovernmental agreement (IGA) adopted by the participating cities (including Carlton by act of the City Council on November 13, 2012), among many other details these cities agreed to distribute the 44.18 cfs according to the amounts listed in **Table 6-2**. A copy of the water rights permit is included **Appendix I** and a copy of the IGA is in **Appendix J**.

Table 6-2 Yamhill Regional Water Authority Water Rights Allocation

City	Allocation
Carlton	2.98
Dayton	3.10 cfs
Lafayette	5.00 cfs
McMinnville	33.10 cfs
Total	44.18 cfs

While many decisions and a lot of work remains before any water flows into any of these city's distribution systems, the permitted water right and the IGA represent significant steps towards increasing the sources of supply for each of these communities, both with regard to total quantities and for an important redundancy that will increase overall system reliability.

The task currently facing Carlton and the other communities in the YRWA is building on the current successes and taking the next steps towards constructing and operating water system facilities. Many difficult decisions must be made not only about what should be built and where, but also concerning the specific incremental steps involved and the pace at which the process should proceed, and as always how will the costs be paid.

When considering construction of a water supply facility on the Willamette we believe it appropriate to include a few comments about the concerns that have been expressed over the years concerning the quality of Willamette River water. Historically, local concern with Willamette River water quality centers around the "Newberg Pool", the portion of Willamette River that stretches from the mouth of the Yamhill River to Willamette Falls. There are two areas of primary concern, namely water quality and fish deformities. The first is based on pollution in river sediments from existing and historical industrial discharges from facilities located within and downstream of Newberg. However, these industrial discharge concerns do not affect the water quality upstream of Newberg (i.e. at Dayton or at Dundee).

Another historical public concern about the Newberg Pool relates to the high incidence of skeletal and spinal deformities in certain species of resident (i.e. non-migratory) fish in this section of the Willamette (being roughly twice the rate observed in portions of the river further upstream). A multi-year study completed in 2004 by a multi-disciplinary team of OSU scientists definitively demonstrated that the deformities were caused by two types of fish parasites which burrow into the bone of young fish and disrupts normal bone development (study presented at the Wilsonville Water Quality Forum 6/30/04). Unlike chemical pollutants, the fish parasites represent little or no risk to human health, as cooking or freezing will kill the parasites in infected fish.

As discussed in more detail in Chapter 7, one potential location for a Willamette River intake structure and pump station was identified on the outskirts of Dayton (i.e. southwest of Neck Road), located immediately adjacent to the Dayton UGB. The east bank of the Willamette River banks in this area is more stable than the portions of the river between Dayton and Newberg. This location is also upstream of the “Newberg Pool”, which will help alleviate negative public perception related to treating Willamette River water for municipal use.

6.3.2.3 Additional Water Rights (Purchase & Transfer)

Existing water-rights can be purchased (with or without purchasing the land to which the water-right is attached), and an application submitted to the WRD to modify the type of use allowed (i.e. from agricultural to municipal), and to modify the approved point of use to match the City’s current water use area.

Currently, agricultural users consume the majority of the nearby groundwater capacity. In an effort to ensure that reliable water supplies are available in the future, the City could consider the purchase of water rights from nearby agricultural users, as these water rights or land become available. This will shift a portion of the finite groundwater capacity from agricultural usage to municipal usage. As noted above, the City would have to file a water rights transfer to change the use from agricultural to municipal, and to change place of use.

As touched on briefly in Section 4.2.2, many of the existing early priority date water rights draw water from relatively shallow, higher producing aquifers. While the shallower nature of the agricultural aquifers results in higher producing wells, it also raises the risk of Ground Water Under Direct Influence of Surface Water (GWUDI) issues when these wells are used as a municipal water source. As part of the evaluation and investigation prior to purchase of an agricultural groundwater right, the City should also get a determination from ODWS as to the susceptibility of the well from a GWUDI perspective. A high producing, early priority date groundwater well with GWUDI issues may still be worth purchasing, but it would require a surface water treatment facility (which should be considered in conjunction with the purchase price of the water-right.

Although we are not counting on the purchase of new water rights for planning purposes, we recommend that the City investigate the purchase of existing groundwater rights that may be associated with agricultural land surrounding Carlton, as discussed in the recommendations section of this chapter. This recommendation is based on the water right owner’s willingness to sell, and thus may or may not provide additional water supply within the planning period.

6.3.2.4 Federal Storage

The US Army Corp of Engineers (COE) currently operates a total of 13 reservoirs within the Willamette Basin to impound water for the purposes of flood control, generation of hydroelectric power, and other conservation uses including water supply. In 1954 the State allocated water rights for the Federal storage volume as irrigation rights, a development that continues to prohibit the OWRD from issuing water rights from this storage source for municipal purposes. As such, the stored water in federal reservoir projects is not presently available for municipal users, and utilization of this water for municipal purposes would require approval from the State of Oregon (in addition to entering into an agreement with the COE to purchase a portion of the uncontracted (i.e. unallocated) storage volume in the federal impoundments). While much of the water stored in COE impoundments is contracted for designated uses, there are significant quantities of uncontracted water that are theoretically available for purchase from the COE. However, the cost to purchase such uncontracted water (once the water rights/water use issues are addressed) is unknown at this time.

The acquisition of new municipal water rights is becoming increasingly challenging and many municipalities in the Willamette Basin have long term water needs that exceed either their water rights or the available water from their sources. The need for water to offset the unavailability of new surface and groundwater rights, and the need for redundant sources, makes Federal storage an attractive consideration for many municipalities. The primary advantage of this approach is that this source is likely to be more reliable than a newly acquired water right with a junior priority date, since storage releases are not considered as part of the natural streamflow, and thus are not subject to the same restrictions as a junior water right during lower flow conditions.

Municipal access to Federal storage is viewed as one of a limited number of options to serve municipal demands in the long term and will likely play a role in municipal water supply after the City's water rights are fully developed, particularly if the regional water supply options discussed below (based on treatment of Willamette River water) are implemented.

6.3.3 Existing Sources, Water Production Reliability

6.3.3.1 Quantity Reliability

Most of the year the quantity of water in Panther Creek is clearly sufficient to met system demands throughout the planning period and beyond. However, quantifying that fact is difficult since no reliable data is available on natural streamflow in Panther Creek above Carlton Reservoir. But, given that Carlton Reservoir is generally full and frequently overflowing provides good anecdotal evidence indicating sufficient streamflow is available.

The sufficiency of natural streamflow during periods of extremely low flow is more difficult to address. Here again routine observations of reservoir levels are the only basis for estimating natural streamflow into Carlton Reservoir during these periods. Per the discussion in Section 4.3.2 it appears that natural streamflow during the summer approximates current demand. Should that be correct, then as demand grows the need for stored water to supplement streamflow for the Panther Creek and Carlton Reservoir combined source will be necessary for the source to be considered reliable with regard to quantity.

In order to develop the necessary data for Panther Creek natural streamflow the City has contracted with GSI Water Solutions to gather streamflow data through the summer of 2013. While representative of only one year, this new data will be a valuable asset for better understanding the reliability with regard to quantity of Panther Creek.

6.3.3.2 Water Quality Reliability

Coming from a large, remote watershed the overall quality of the Panther Creek/Carlton Reservoir source is considered good. However, it has a number of circumstances that create recurring challenges and risks to the reliability of the source.

6.3.3.2.1 Silt and Debris

Under normal conditions, including typical large winter storms the silt and suspended debris carried by Panther Creek into Carlton Reservoir does not pose a significant problem for the water treatment plant, thus the system is able to reliably provide good quality water most of the time. However, the potential does exist for certain events, such as a landslide or major watershed flooding, to generate silt loads that could challenge and even possibly overwhelm the abilities of the water treatment plant. Since the water treatment plant is equipped with the normally unused raw water screen and the tube settler pre-treatment system, both of which are intended to assist during periods of exceptionally high turbidity, the plant is believed to have the ability to handle fairly challenging conditions.

Even so the potential does exist for silt loading to exceed the ability of the plant to operate satisfactorily. If this is caused by major flooding, typically the plant could be taken off line for a few days at which point the storm would likely have passed and silt concentrations to have started to taper off.

It is also appropriate to note here that long term silt accumulation is occurring in Carlton Reservoir as is evidenced by the growing bar at the upper end. It is also believed that substantial silt accumulations of several feet or more may exist across much of the reservoir bottom. Such accumulation has a variety of detrimental effects including reduction of storage volume as well as increasing temperatures leading to higher algae growth.

As mentioned earlier, Carlton Reservoir is estimated to have a total storage volume of roughly 60 acre feet without any silt accumulation on the bottom. With a surface area of approximately 4 acres, an average depth of silt of only 3 feet would reduce the total volume by 12 acre feet, or approximately 20% of the reservoir volume.

6.3.3.2.2 Algae

Carlton Reservoir is subject to algae blooms during the spring and summer. If left unchecked the quantity of algae can act to clog the water treatment plant filters. To control the algae the City uses Earthtec, an NSF approved algicide for lakes and ponds. This has proved to be a successful method of algae control such that algae is not considered a significant concern for water quality reliability.

6.3.3.2.3 Iron and Manganese

Overall the iron and manganese found in Panther Creek and Carlton Reservoir do not cause significant water quality concerns. The concentrations are highest in the summer when natural streamflow is lowest. To reduce iron and manganese levels in the finished water the treatment plant influent is chlorinated which oxidizes the iron and manganese allowing it to be removed by the filters.

6.3.3.2.4 Other Contamination

As with any surface water source there is always some risk of contamination from unknown or unauthorized sources in the watershed. Given the remote area, limited and difficult access the potential for significant contamination of Panther Creek and/or Carlton Reservoir is considered comparatively small.

6.3.4 Existing Sources, Infrastructure Reliability

The infrastructure for delivering the source water from the source to the water treatment plant is extremely simple and considered highly reliable. The infrastructure involved is essentially an open pipe attached to the raft in Carlton Reservoir and to the inlet box at the base of the dam, continuing to another open pipe through the dam and down the hill to the treatment plant. The whole system has no moving parts and is powered by gravity.

The potential threats to this infrastructure include deterioration such as is believed may be occurring at the inlet box connection where increased silt and debris loading into the plant appear to indicate that the inlet box or the connection with the upstream pipe is beginning to fail. Further inspection of this situation, as well as possible repairs should be completed to ensure a larger failure of this component does not occur.

6.3.5 System-Wide Water Source Reliability

Two criteria for evaluating water system source reliability as a whole were introduced in Section 6.2.2.1. These were:

- *Two or more sources of water supply should be developed with a total capacity to replenish depleted fire suppression storage within a 72-hour period while concurrently supplying MDD.*
- *When the largest single source is out of service, the remaining sources should be able to satisfy MDD (capacity with the largest single source out of service is referred to as firm capacity).*

Applied literally and directly, the Carlton water system is lacking in system wide source reliability because it only has one source and thus can't explicitly meet either of these criteria. Under these circumstances several considerations are appropriate.

6.3.5.1 Highly Reliable Single Source

As discussed above, the overall reliability for the Carlton water system both with respect to quantity and quality is very good. Historically there has been adequate water in Panther Creek on a continual basis, and the quality risks to the supply are limited and generally addressable by the treatment plant capabilities or other reasonable means. It could be argued that one highly reliable source like Panther Creek and Carlton Reservoir is better than less reliable sources.

6.3.5.2 Old Carlton-McMinnville Emergency Interie

Lacking a formal agreement with the City of McMinnville, this intertie is not available for the City to use. But, it does stand as a potential opportunity that should be kept in mind should exceptional circumstances occur. Furthermore, in preparation for such exceptional circumstances it would be beneficial to the City of Carlton to continue to work towards formalizing an agreement with the City of McMinnville that would clearly define the conditions under which Carlton could make use of this intertie and the procedures for and parameters governing its use should it be needed.

6.3.5.3 Yamhill Regional Water Authority (YRWA)

The creation of the YRWA provides a mechanism by which the future reliability of Carlton's water system can be greatly improved. In addition to the additional quantity of water allotted to Carlton as part of the YRWA, for Carlton to participate in the YRWA some system intertie would be needed. Upon completion of such an intertie as part of the YRWA Carlton would have a second highly reliable water source.

6.3.5.4 Fall Creek Water Right

Situated roughly 3/4 of a mile to the southeast of the water treatment plant the potential does exist to make use of this water right should circumstances require it. To do so would require infrastructure that does not currently exist, but could be developed either as temporary or permanent improvements. However, before doing so significantly more and better information on the quality and quantity of the Fall Creek water source would be needed.

6.4 RECOMMENDED APPROACHES & IMPROVEMENTS

Overall the City of Carlton is in comparatively good shape with regard to its water source situation considering water rights, availability and quality. Even so, there are issues to address and actions to be taken with respect to both the Panther Creek/Carlton Reservoir water source and the various other undeveloped water sources.

The recommended improvements and studies are summarized in **Table 6-3** (at the end of this chapter).

6.4.1 Water Loss Reduction (Transmission & Distribution Improvements)

As discussed in Section 5.4.7, the water loss experienced by the Carlton transmission and distribution system is significant, with an estimated 40% of total production entering the system being lost, largely to leaks from the piping. Per the earlier analysis, it is believed that roughly two-thirds of this loss occurs in the Treatment Plant Finished Water Line while the other third occurs in the Meadow Lake Road Transmission Main and the Distribution Mains.

Although a water loss ratio of zero is desirable in theory, it is not typically feasible given the complexity and practical realities associated with municipal distribution systems. A typical and reasonable water loss ratio goal for small municipalities is a 10% to 15% loss rate.

When prioritizing water system improvements, the City should bear in mind that reduction in distribution system leakage is actually equivalent to obtaining new sources (since more water is available for use to meet consumption requirements). It has the additional benefit of reducing the unit cost required to produce water from the City's existing sources, since the City is no longer paying for producing and treating water that leaks into the ground (i.e. the City is already paying to produce and treat the leakage water, but does not receive any revenue from this water since it does not pass through a water uses meter).

Further reduction in water losses from the in-town distribution system and replacement of the watershed transmission main will have the same effect as increasing the source production available for use by consumers.

Recommendations for distribution system improvements that will reduce water loss (and increase the effective volume available from the City's existing sources) are included in Chapter 8.

6.4.2 Water Rights and Regulatory Issues

Several water rights issues need to be addressed by the City during the study period relating to water supply availability and completing permitted water rights, which are identified below.

6.4.2.1 Tracking Panther Creek Flows

The City currently does not have a method in place to measure streamflow on a regular basis in Panther Creek above Panther Creek reservoir. Consequently, the City lacks data regarding how much of its water supply comes from Panther Creek "natural streamflow" versus stored water in Panther Creek reservoir. Although the City appears to have sufficient Panther Creek water rights to meet demand for many years, the reality is that available streamflow in Panther Creek may be sufficient in early summer only; streamflow is typically insufficient in mid to late summer to meet demand on peak days. In these cases the City is meeting its water supply demand from stored water. Panther Creek streamflow data will enable the City to: understand water availability compared to water rights in Panther Creek; inform the City of when it must rely on stored water; inform the City on how much "stored water" is being used; and how other sources - Fall Creek and the Willamette River via the Yamhill Regional Water Authority – might be needed to meet future demands.

6.4.2.2 Water Right Permits/ Extensions

The City has four water right permits that require additional effort to complete. The City has three permit extensions currently pending at OWRD that need to be updated based on the demand projections developed as part of this Water System Master Plan. In February 2012, ODFW provided its proposed fish persistence conditions for Permit S-34661, a water right permit for use of 0.229 cfs from Panther Creek, and Permit S-32488, a water right permit for use of 2.0 cfs from Fall Creek. OWRD proposed to approve an extension of time on November 2, 2010 for Permit S-32489, a water right permit for use of 2.5 cfs on Panther Creek, but the extension of time was protested by a third party. For Permit S-32489, the City will need to decide whether to continue pursuing the protested extension through a contested case hearing or modify the request and go through the ODFW fish persistence process. In addition, a permit extension for Permit S-50128 needs to be developed using the updated demand projections and submitted to the OWRD.

6.4.2.3 Water Rights versus Water Availability

As described above, the City's ability to fully use its water rights is affected by water availability in Panther Creek and conditions placed on water rights permits during the permit extension process. Panther Creek does not have adequate flows in late summer for the City to fully exercise its 3.57 cfs of Panther Creek natural flow water rights. Consequently, the City will need to rely on stored water and, as demand grows, on its redundant water supply options during late summer. Fish persistence conditions included in permit extensions for Panther Creek and Fall Creek will likely restrict water diversion from these sources when streamflow falls below a particular level. As a result, a portion of the water from these two sources could become unavailable earlier in the summer.

6.4.2.4 Certificating Water Rights and Water System Capacity

A constraint on certification of the remaining permits is the City's system capacity. On July 1, 2009, a peak day in early summer with additional operational water needs, the City collected information demonstrating the beneficial use of 2.979 cfs over a 4 hour period. Upon extension approval, the City will seek certification of 2.19 cfs of Permit S-32489 (for a total of 2.979 cfs of water that can be beneficially used (0.789 cfs in existing certificates + 2.19 cfs under Permit S-32489 = 2.979 cfs). Thus, of the 3.57 cfs of Panther Creek water rights, 0.591 cfs remain to be certificated (a demonstration of beneficial use in addition to all the existing certificated water rights at the same point of diversion). The City estimates that operational needs and potential large water users will require full beneficial use of the remaining 0.591 cfs of Panther Creek water rights in the next 20 to 30 years. At this point, when system capacity is increased, the City could demonstrate beneficial use of the unperfected portions of Permits S-32489, S-34661, and S-50218.

6.4.2.5 Water Supply Redundancy

The City has water right permits for use of Fall Creek and the Willamette River that may provide water supply redundancy when Panther Creek has insufficient flows to meet City demand or is not usable, such as due to contamination. Permit S-32488 is for 2.0 cfs from Fall Creek. The diversion and conveyance infrastructure for Permit S-32488 have not been constructed yet. Given that the City has already used 2.979 cfs of its Panther Creek water rights, the City could potentially fully beneficially use Permit S-32488 upon completing construction of infrastructure to ensure a redundant water supply of 2.0 cfs that could meet a large portion of demand on a peak day. Understanding the amount of water available (and the quality of the water) in Fall Creek will be a key step for the City to undertake prior to development. The City will also need to decide on a strategy for financing and developing the infrastructure.

As a member of the Yamhill Regional Water Authority, 2.98 cfs of the 44.18 cfs allowed under Permit S-54792 for Willamette River water is allocated to the City. The diversion, regional water treatment plant, and other necessary infrastructure for Permit S-54792 remain to be built, which will take many years and makes access to the City's 2.98 cfs under the permit uncertain during a considerable portion of this 20-year planning period.

6.4.2.6 Water Conservation Plans & Policies

The City has been implementing water conservation measures despite staff and resource limitations. The City's water conservation measures are described in a Water Management and Conservation Plan (WMCP) that the City is currently developing to anticipate water right regulatory requirements for the permit extensions described above. Generally, under the current permit extension process a WMCP (or WMCP updated) is required within 3 years of a permit extension approval when there is a portion of the permit that is currently "undeveloped."

The OWRD's final order approving the City's WMCP will include requirements that the City submit a progress report five years after the date of approval and an updated WMCP within ten years of approval.

6.4.3 Improvements to Existing Sources

There are a number of improvements recommended to the City's existing water supply sources, as summarized below.

6.4.3.1 Carlton Reservoir Dredging/Silt Removal

Constructed in the early 1970's, Carlton reservoir has accumulated more than 40 years worth of silt and debris. In addition to regular silt inflow the quantity of silt in the reservoir has been significantly increased by events such as landslides and exceptionally large winter storms such as those experienced during 1996. We recognize that the City is aware of this problem and desires to do something about it. But because of the reservoir location and nearby geography the task is likely to be difficult. We believe the appropriate course of action is to undertake a preliminary engineering study to identify and evaluate possible alternatives for removing the silt. Should a promising alternative arise, the next step may be a small scale effort to attempt to remove some of the easiest areas under optimal conditions. That type of project may be helpful in developing a program for a larger, more comprehensive effort.

6.4.3.2 Carlton Reservoir Inlet Box Repairs

The inlet box in the reservoir is an essential element of the water supply system. Due to the silt accumulations believed to cover and surround the structure a complete, long-term repair may be difficult to achieve until successful silt and sediment removal occurs. This places an even greater priority on developing an effective means for removing the silt and sediment from the floor of the reservoir. Once access is available a proper assessment can occur, and given the generally simple nature of the structure, the repairs and improvements may prove comparatively straightforward.

6.4.3.3 Panther Creek Streamflow Monitoring

The lack of long term data on the natural streamflow in Panther Creek creates an unnecessary uncertainty on long term planning regarding much of Carlton's water system infrastructure needs. Without actual data all source estimates must be based on guesses and estimates from circumstantial evidence.

6.4.4 Water Source Recommendations Summary Table

Table 6-3 is a brief summary of the various water source improvement recommendations developed by this master plan. For more details on particular projects, refer to the discussions in the body of the study.

Table 6–3: Recommended Water Supply Improvements & Projects

Project Code	Project
S-1	Panther Creek Reservoir Contingency Reserve
S-2	Carlton Reservoir Dredging/Silt Removal
S-3	Intertie Connection, WTP with McMinnville Water & Light
S-4	Carlton Reservoir Inlet Box Repairs
S-5	Upon approval of an extension of time, partially perfect 2.19 cfs of Permit S-32489
S-6	Update extensions of time for Permit S-34661 and Permit S-32488.
S-7	Develop and submit an extension of time for Permit S-50218.
S-8	Install a system that regularly measures streamflow in Panther Creek upstream of Panther Creek Reservoir.
S-9	Water Management & Conservation Plan update when required by OWRD.

CHAPTER 7

WATER TREATMENT EVALUATION

Chapter Outline

WATER TREATMENT EVALUATION

CHAPTER 7

7.1 INTRODUCTION

This chapter builds on the regulatory requirements presented in Chapter 3, the inventory of the City's water treatment infrastructure as presented in Chapter 4 and the City's future water demands as developed in Chapter 5 to assess Carlton's present and future water treatment needs and current water treatment capabilities. It then provides recommendations for changes to the City's water treatment system designed to achieve regulatory compliance and meet demands during the planning period.

The chapter begins with the identification of treatment objectives and the various methods and processes used to meet those objectives. This is followed by an evaluation of the current water treatment plant processes with regard to current and anticipated goals and requirements. The final part addresses proposed treatment system process and capacity modifications including recommendations for specific changes. Capital costs for the recommendations presented in this chapter appear in Chapter 12.

7.1.1 Source Water Characteristics

Treatment objectives vary depending on the source water characteristics (groundwater versus surface water, chemical composition, etc.). For the purposes of this study the focus will remain on surface water treatment issues because all of the City's existing and prospective sources are surface water sources. Discussion of ground water source treatment will be limited and cursory for reference purposes only.

Source water is addressed in detail in Chapter 6. Overall, Carlton's Panther Creek/Carlton Reservoir water source provides a reliable supply of good quality water. The potential source concerns include:

- Periodic high levels of turbidity
- Siltation of the reservoir impoundment
- Seasonal increases in iron and manganese concentrations
- Seasonal algae blooms

7.2 TREATMENT OBJECTIVES

Water treatment, as accomplished by a centralized plant, is the result of a series of discrete process units. Each process unit provides a specific treatment function as water passes through the treatment plant in a step-by-step process. The combination of these incremental treatment steps creates a treatment 'train' whose finished water product is intended to meet regulatory standards and overall treatment objectives.

The WTP should posses treatment processes capable of meeting current standards and objectives with an operating margin that allows the City to also successfully meet projected increased demand and anticipated near term regulatory requirements.

7.2.1 Inactivation/Removal of Microbial Contaminants

One of the biggest water treatment concerns is microbial contaminants. As a surface water source, Panther Creek/Carlton Reservoir is subject to the more comprehensive microbial contaminant treatment requirements placed on surface water sources. Use of the Fall Creek or Willamette River sources would also be subject to the same regulations. By contrast, there appears to be little likelihood for the City to have a groundwater source of any time, whether true groundwater or GWUDI (groundwater under direct influence) of surface water.

Microbial contaminant treatment objectives for each of the three categories of source water are presented below.

7.2.1.1 Microbial Treatment Surface Water Sources

The following is a brief summary of the regulations governing microbial treatment of surface water sources. See Chapter 3 for a more extensive discussion on this topic.

The following regulations govern this facet of water treatment:

- Total Coliform Rule (TCR)
- Revised Total Coliform Rule (RTCR)
- Surface Water Treatment Rule (SWTR)
- Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR)
- Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)

Based on these regulations the following requirements must be met:

- 4-log treatment for viruses
- 3-log treatment for *Giardia lamblia*
- 2-log treatment for *Cryptosporidium*
- Disinfection before discharging to the distribution system
- Minimum disinfectant residual of 0.2 mg/L at entry point, detectable levels everywhere
- Coliform testing
- No fecal coliform or E. coli detected in Coliform Testing
- Turbidity sampling
- Maximum turbidity of 0.3 NTU in 95% of samples, 1.0 NTU in any sample

7.2.1.2 Microbial Treatment GWUDI Sources

Microbial treatment for GWUDI sources is essentially the same as for surface water sources. However, given the nature of the sources, the physical infrastructure needed for GWUDI sources is typically less than that for surface water sources. This is because concerns about debris, sediment, silt and high turbidity levels are greatly reduced.

7.2.1.3 Microbial Treatment, Groundwater Sources

The Ground Water Rule (GWR) is the primary regulation governing treatment standards for true groundwater sources. Compliance with the GWR requires 4-log (99.99%) inactivation of viruses and compliance monitoring (continuous monitoring of chlorine residual) in order to avoid being subject to the requirements of triggered monitoring.

Failure to provide the 4-log virus inactivation requires a water system to be operated under the triggered monitoring mode, which requires more extensive sampling in the event of any positive routine coliform testing. Triggered monitoring is viewed as a necessary transitional phase prior to the upgrade of the system to meet the 4-log virus inactivation standard and compliance monitoring requirements. When triggered monitoring occurs (4-log inactivation is not being provided) the expectation is that new permanent facilities will be designed and constructed that will reliably and efficiently achieve 4-log virus removal/inactivation.

7.2.2 Other Treatment Objectives

7.2.2.1 Taste & Odor

Taste and odor, at objectionable levels, occurs in many water utilities nationwide and although the safety of the water in these systems is not at risk, consumers may perceive that the water is unsafe to drink because it has an unpleasant smell or taste. The City does not currently experience significant taste and odor problems, primarily because the water treatment plant provides iron and manganese removal, which addresses the most likely source of taste and odor complaints.

7.2.2.2 Disinfection Byproducts

As discussed in Chapter 3, the use of chlorine to disinfect the drinking water may result the creation of health hazards related to the chemical reaction between the chlorine and natural source water constituents. Therefore a balance must be achieved between sufficient chlorine to meet microbial contaminant requirements, and too much chlorine resulting in excessive disinfection byproducts.

7.2.2.3 Lead and Copper

Lead and copper in drinking water have been identified as health risks with concerns such as those below (taken from the US EPA web sites):

- Infants and children who drink water containing lead in excess of the action level could experience delays in their physical or mental development. Children could show slight deficits in attention span and learning abilities. Adults who drink this water over many years could develop kidney problems or high blood pressure.
- Some people who drink water containing copper in excess of the action level may, with short term exposure, experience gastrointestinal distress, and with long-term exposure may experience liver or kidney damage.

Since lead and copper may be present in private plumbing systems and treated water with a low pH (acidic) increases the rate at which lead and copper dissolve, it is necessary to ensure that the pH in the City's water system is controlled to limit lead and copper concerns.

7.3 TREATMENT PROCESSES

This section addresses different aspects related to the generalized treatment alternatives. In Section 7.4 these general principles are applied to an evaluation of the existing water treatment plant.

As described above water treatment involves a series of individual steps that make up the treatment train. Each step is designed to accomplish a particular object or set of objectives with the goal of having the treated water and the end of the treatment train meeting all of the established regulations and treatment objectives.

The following sections step through the City's water treatment system in order to describe each individual process and the purpose for that process within the treatment train.

7.3.1 Algae Control

Carlton Reservoir is subject to algae blooms in the spring and summer. Algae in the water entering the plant provides additional demand on the filters reducing plant efficiency and capacity. To reduce the algae in Carlton Reservoir, the City has been using Earthtec, an NSF approved algicide for lakes and ponds, which has been an effective algae control measure.

7.3.2 Pre-Filter Sediment and Debris Control

As mentioned in the water treatment plant infrastructure section, the plant is equipped with a raw water screen and a tube-settler pre-treatment system. These components are designed to provide initial reduction in sediment and debris when the influent coming from Carlton Reservoir is carrying exceptionally high quantities of sediment due to major storm events or other causes.

7.3.3 Pre-Filter Chemical Injection

7.3.3.1 Coagulation and Flocculation

The filters are a key part of the water treatment train, physically removing particles from the water. The larger the particles, the more effective the filter is at removing them. Coagulation and flocculation is a process where small particles come together into larger and larger clumps, at which point they either settle out of the water column or become much easier to remove by the filter.

The City is currently using liquid alum (aluminum sulfate, 48%) for pre-filter coagulation and flocculation, dosing at a rate of approximately 8.5 mg/L. The City previously used granular alum that was mixed on site, but believes it is getting better results with the liquid.

7.3.3.2 pH Adjustment

The effectiveness of alum for producing floc is dependent on the pH of the water. If the pH is too high (8.0 or higher) the floc may become unstable and break up. If the pH is too low (below 6.5) the alum may dissolve, rendering it worthless for the development of floc.

The treatment plant is configured to provide pH adjustment as part of the pre-filter coagulation and filtration process. While sodium hydroxide is available and used for post-filter pH adjustment, the City is not currently performing pH adjustment prior to the filters.

7.3.3.3 Chlorination

Chlorination of the influent arriving at the treatment plant is used to precipitate iron and manganese out of solution by oxidation. This process is more effective for iron (which reacts quickly), than for manganese (which reacts more slowly). The fast reaction time for iron means that the iron comes out of solution before the flow reaches the filters. The slower reacting manganese may pass through the filter before oxidation occurs, resulting in manganese concentrations developing in the system downstream of the filters.

One of the potential consequences of pre-filter chlorination for iron and manganese removal is the formation of disinfection byproducts. The quantity of disinfection byproducts is related to the amount of organic material in the water. Thus, higher amounts of organic material before the filters tends to increase the potential that the combination of chlorine and organic material could produce disinfection byproducts.

7.3.4 Filtration

Filtration as a water treatment process is commonly required in water systems with surface water sources or those classified as GWUDI. The primary purpose for filtration in many surface water treatment plants is to reduce the quantity of suspended particles (turbidity), with the underlying goal of reducing or eliminating microbial contaminants which inhabit and are nourished by these particles. Surface water filtration can also be used for controlling other contaminants such as iron and manganese, which can be oxidized, adhere to floc, and be captured by the filter. Filtration is less commonly required for the treatment of groundwater, but when required, it is most often used to remove iron and manganese.

Carlton's water treatment plant includes direct filtration, with the primary purpose of reducing turbidity and removal of microbial contaminants, and is also used to reduce iron and manganese concentrations at certain times of the year.

7.3.5 Post-Filter Chemical Injection

7.3.5.1 Disinfection for Microbial Inactivation

Inactivation of microbial pathogens with a disinfectant complements removal rates achieved through the filtration process. The City currently disinfects with chlorine gas injected into the plant piping after the filters.

7.3.5.2 pH Adjustment

As mentioned above, the City is currently using sodium hydroxide for post-filter pH adjustment. Adjusting the pH at this point is intended for corrosion control purposes, to reduce the potential for lead and copper (which may be present in private plumbing systems) from dissolving into the drinking water.

7.3.6 Plant Reliability and Redundancy

A key treatment objective is to be able to provide treatment of the ADD in the event of a disruption or failure of any single process component. This is based on the reasonable assumption that the difference between ADD and either PHD, or MDD, can be satisfied by storage reserves or by water use curtailment on an emergency basis. In such cases, timely notification of consumers is critical and an emergency notification and curtailment plan is essential to quickly reduce water demand.

7.4 EXISTING WTP EVALUATION

A detailed summary of the City's existing WTP is contained in Section 4.4.4, and treatment objectives and criteria are presented in the previous sections of this chapter. This chapter evaluates each part of the water treatment system to identify potential critical areas or weaknesses needing attention.

7.4.1 Treatment Plant Capacity

7.4.1.1 CT Time Imposed Restrictions

The treatment plant capacity is governed by the most restrictive component. As presented in the recent Water System Survey, currently the most restrictive part of the water treatment train is the chlorine contact time provided by the clearwell. Based on a tracer study conducted in 2010 (to measure the actual contact time), maximum flows in excess of 473 gpm will result in CT values less than the allowable minimums. A copy of the tracer study is included in **Appendix K**.

While the 473 gpm limitation does not pose an immediate problem, if it were an absolute limitation it would significantly restrict the ultimate capacity of the water treatment plant. If the clearwell discharged non-stop at 473 gpm, the total discharge would be 0.681 MGD. Looking back to Chapter 5 (Table 5-18) we find the projected maximum day demands through 2033 as follows.

(from)Table 5-18 Summary of Projected Water Demands

Year	2012	2015	2020	2025	2030	2033
Max Day Demand (MGD)	0.533	0.535	0.560	0.592	0.622	0.642

Since daily demand cycle fluctuations are likely to preclude a continuous discharge from the clearwell to the finished water storage reservoirs, it appears that the 473 gpm limitation may result in a failure to meet MDD during the planning period. By 2033 the clearwell will need to be discharging at the maximum allowed rate (473 gpm) for 22.4 hours out of 24.

The purpose of the tracer study was to determine the time that lapsed from when the disinfecting chlorine is injected into the finished water stream until the chlorine treated water reaches the first user in the distribution system. This time is a key component in calculating the disinfection capacity of the system. Disinfection is governed by the strength of the disinfectant (the concentration of the chlorine in solution) and the time it has to work (the time from injection until the flow reaches the first user). The multiplication of these two factors is known as CT time. The effectiveness of chlorine as a disinfectant is also influenced by the temperature of the water (the higher the temperature the more effective the chlorine) and the pH of the water (the lower the pH the more effective the chlorine).

Based on extensive historical testing and analysis, the factors governing the effectiveness of chlorine inactivation of Giardia (chlorine concentration, time, temperature, and pH) have been compiled into CT tables that show the level of inactivation that have been determined to occur under various conditions. Select tables were included in the 2010 tracer study.

Since Carlton receives a 2-log credit for Giardia removal for filtration, only 1-log inactivation by disinfection is required to reach the required total 3-log combined reduction by removal and inactivation. Because required CT time is dependent on temperature, pH and chlorine dosing rates, it is possible to get higher flow rates through the Clearwell when temperatures are higher and/or higher chlorine dosing rates are used. The following discussion starts with the conditions assumed for the tracer study, and then evaluates higher temperature and dosing rate conditions to show the difference in potential flow rates without constructing any physical changes to the clearwell.

From the table on Page 5 of the tracer study we find values for water at 5°C (41°F). In the section for pH = 7.5, in the column for 1.0-log inactivation, on the row for a chlorine concentration of 1.6 mg/L we find a CT value of 64. The table on Page 6 is for water at 10°C (50°F) and the applicable CT value is 48, and on Page 7 for water at 15°C (59°F) the applicable CT value is 32. The important fact to note here is the substantial decrease in CT values as temperature increases.

To estimate the ultimate maximum flow rate through the clearwell it is useful to look at the calculated CT value of the test conditions. For normal operating conditions (Test #3) the actual CT value provided was

108. That is saying that the actual CT value for the water in Test #3 was 108, which was computed from a C (chlorine concentration) of 1.5 mg/L and a time of 72 minutes (C x T = 1.5 x 72 = 108). By comparison, since August water temperatures are typically 15°C or above, at a chlorine concentration of 1.6 mg/L the required CT value is only 32. That is to say in August the system operating at the current allowed rate of 473 gpm provides CT of 108, but only needs to provide a CT of 32.

It is possible to estimate theoretical CT time under any given circumstances. Since the chlorine concentration is set by the dosing rate, the unknown is the contact time. Using standard CT estimating procedures we believe that the plant could be operated at summer temperatures at or even above the maximum rate provided by the filters, 975 gpm while still meeting CT requirements.

For the purposes of this study, while the clearwell is currently limited to a maximum discharge of 473 gpm, that limitation is not representative of the actual capacity. This value could be increased well above the current limitation should the City desire to do so. One approach to increasing the flow rate through the clearwell would be to work with ODWS to develop allowable operating parameters that take into account water temperatures. Any such change would require a new tracer study, which can typically be arranged through ODWS at no cost to the City.

7.4.1.2 WTP Finished Water Line

The WTP Finished Water Line runs from the WTP to the finished water storage reservoirs. This is discussed in more detail in Chapter 8. The important point is that under continuous operation, the WTP output is limited by the capacity of the WTP Finished Water Line. At its present size, this line is estimated to have a capacity in the range of 700 gpm or 1.0 MGD under continuous flow for 24 hours.

Because this line is leaking significantly, it is recommended for replacement. The current pipe is 10-inch diameter for the western 3/4-mile, with the remainder being 12-inch diameter. If replaced with newer 12-inch pipe for the entire length it is estimated that the capacity would increase to approximately 950 gpm (1.4 MGD). While the existing capacity of 700 gpm is adequate for the planning period, this pipeline will remain in service well beyond the 20 year planning period of this report. Therefore, using 12-inch minimum diameter for the entire length is recommended at the point in time when replacement occurs.

7.4.1.3 Filter Capacity

Per Section 4.4.1.5, the total filter capacity of the WTP (with all four filters in operation) is 975 gpm, or about 1.4 MGD total capacity. This needs to be reduced by the water used for backwash and other miscellaneous uses, and also by lost filter time while the plant is in the backwash and filter-to-waste cycle. With these deductions, under continuous operation the net filter capacity is estimated at around 1.1 MGD. This is fully adequate for anticipated demands during the planning period.

7.4.2 Turbidity Control

7.4.2.1 Performance

As discussed above, the WTP filters serve to remove particulates from the raw water. This is a key part of the treatment process since the particulates serve as a host for microbial contaminants, as well as shielding the microbial contaminants from disinfection. The WTP filters have consistently performed well in the meeting regulatory requirements for 95% of readings to be less than 0.3 NTU and no readings over 1.0 NTU.

7.4.2.2 Profiling

While the filter performance has been satisfactory, the recent Water System Survey identified the need for filter profiling. The Drinking Water Program requires that each filter be profiled each quarter. Profiling involves detailed time based turbidity readings being taken through the filter-to-waste cycle in order to determine the water quality as the flow settles down from the backwash to normal production mode.

Profiling is beneficial because it gives the operator a clearer picture of the performance of each filter, allowing developing problems to be spotted earlier, and it allows the time period for ending filter-to-waste runs and resuming production to be set more accurately. This ensures that good water is not wasted if filter-to-waste cycles too long, and that turbidity requirements are successfully met.

Public Works staff is addressing the concerns raised in the Water System Survey by implementing the Drinking Water Program recommendations.

7.4.3 Control of Microbial Contaminants

Microbial contaminants are primarily handled in two ways, by removal and by inactivation. The effectiveness of each method differs depending on the microbial constituent.

- Giardia Lamblia requires both removal and inactivation to meet treatment objectives.
- Viruses are readily handled through inactivation.
- Cryptosporidium are resistant to inactivation, and thus are primarily handled by removal.

7.4.3.1 Giardia Lamblia

As previously described, 3-log (99.9%) removal is required for Giardia. For the Carlton WTP this is achieved in two parts. The plant, when operated in conformance with applicable rules, guidelines and accepted practices, is given credit for 2-log removal of Giardia by the filters. Plainly stated, based on historical demonstrated performance for plants of this type, the filters are assumed to remove at least 99% of any Giardia that may be present in the incoming flow.

However, this only achieves 2-log of the required 3-log treatment. The remaining 1-log is accomplished by chlorine disinfection prior to the flow entering the distribution system. This is where the CT time for the clearwell becomes critical. The CT tables are based on experimental data for a wide range of conditions. If the table parameters are followed, the successful inactivation of the remaining Giardia is assumed to occur.

7.4.3.2 Viruses

Viruses are much more easily treated (inactivated) by chlorine than Giardia. As long as the WTP is operating as required to achieve the necessary level of inactivation of Giardia, the mandated 4-log inactivation of viruses is assumed to be occurring.

7.4.3.3 Cryptosporidium

Cryptosporidium is generally resistant to chlorine inactivation and therefore is primarily controlled through removal. The current regulations require 2-log removal of Crypto, and as with removal for Giardia, the WTP filter system is credited with 2-log removal of Crypto as long as the plant is operating properly.

The Long Term 2 Enhanced Surface Water Treatment Rule was created to provide additional protection for systems seen as high-risk for Crypto in the source water. Rule implementation is occurring in steps. For systems serving less than 10,000 people, the initial step was E. coli testing. Based on the results of that testing, each water system was placed in a Bin category that mandated differing levels of additional water treatment over and above the 2-log removal currently required for Crypto. The initial testing placed Carlton in the lowest level (Bin 1), which requires no additional treatment. Carlton must complete as second round of E. coli testing by October 2017. Should this second round of testing result in Carlton being assigned to a higher Bin, the City would need to add treatment capability to further remove Crypto.

7.4.4 Iron and Manganese Removal

When deemed necessary, the WTP also provides iron and manganese removal through pre-filter chlorine injection to oxidize the iron and manganese, so that it precipitates out of solution into a form that can be removed by the filters. As previously discussed, the reaction rate for the iron is much faster than for the manganese, making the removal of iron by the filters much more effective than manganese.

With regard to manganese, the slower reaction rate results in the manganese precipitation occurring after the filters. This results in manganese deposits occurring in the distribution system, which must be periodically removed by flushing.

Overall, the iron and manganese removal program currently used by the City appears to be working satisfactorily, and no changes are recommended.

7.4.5 Lead and Copper Control

As discussed above, the City is currently injecting sodium hydroxide into the finished water for pH adjustment for the purposes of lead and copper control. The City has been in compliance with the lead and copper regulations since July 1995, and there does not appear to be any reason for concern about this issue as long as current practices are continued as planned.

7.4.6 Disinfection By-Products (DPB)

The use of chlorine as a disinfectant has the potential to create unhealthy byproducts when the chlorine comes in contact with certain common source water constituents (typically dissolved organic material). The City always injects chlorine after the filters for disinfection purposes. Depending on the conditions as described above, the City does at times also inject chlorine prior to the filters for iron and manganese control.

The potential for disinfection by-products increases with increasing chlorine dose and also increases with higher turbidity in the water. Thus, injecting chlorine before the filters can increase the potential for by-products to form.

The City uses moderately high chlorine concentrations for disinfection. The minimum chlorine concentration required at the discharge from the clearwell is 0.2 mg/L, and the City generally maintains a residual between 1.5-2 mg/L. The maximum allowable chlorine concentration is 4.0 mg/L.

During the course of the Water System Survey, ODWS expressed some concern that the higher chlorine concentrations could result in failure to meet DPB standards.

While this concern is understandable, based on records dating back to 2002 the City has consistently been in compliance with DPB regulations.

There have been some values that approached the regulatory limits such as a TTHM measurement of 0.07 mg/L out of the allowable 0.08 mg/L in 2008, and several HAA5 measurements above 0.05 mg/L out of the allowable 0.06 mg/L in the period from 2004-2007. These readings indicate that the potential for falling outside the allowable limits does exist. However, it appears that current practices are satisfactory and no changes are needed. Should the City consider increases to its current chlorine levels, we recommend that possible increases in DBPs be considered and chlorine levels be increased incrementally and DBPs monitored during the process.

7.4.7 Water Treatment Plant Physical Condition

With the WTP expansion now approximately 10 years old the WTP plant and grounds remain in excellent condition. To the best of our knowledge the building, clearwell and major equipment and piping have no known deficiencies or issues of concern. Continued regular upkeep should allow the plant to continue to operate as designed throughout the planning period.

The one item identified as a significant expense that should be anticipated during the planning period is the repainting of the clearwell. The exterior paint is showing some signs of weathering consistent with its age. The interior was not inspected but is also expected to be in normal condition for a 10 year old tank. A detailed coating inspection was outside the scope of work for this study. Based on typical manufacturer's recommendations, welded steel reservoirs should be recoated at about 15 years maximum intervals

7.5 REGIONAL SURFACE WTP EVALUATION

As discussed earlier in this study, the cities of Carlton, McMinnville, Dayton and Lafayette have formed the Yamhill Regional Water Authority (YRWA) and secured water rights on the Willamette River. A new Willamette River source will require a new intake screen and intake pump station, raw water transmission lines and a surface water treatment facility. Given its size, we believe that the development of a regional surface water source and treatment plant will require a significant leadership role by the City of McMinnville, as well as meaningful contributions by Carlton, Dayton and Lafayette.

Because of its closer proximity to the Willamette River, the area near Dayton is being considered as a possible location for a regional water treatment facility. As part of Dayton's recent Water Master Plan, a field investigation by land and boat was performed to evaluate potential raw water intake locations along the Willamette River. Due to extensive flood plains and unstable river banks, options in the Dayton area were found to be limited. One area was located which appears to have a stable bank on the west side of the river, without the extensive erosion and slide zones apparent in many other locations.

At the location shown on **Figure 7-1**, the river bank extends well above the river and the flood levels, and appears to be composed of consolidated mudstone over consolidated mudstone/sandstone deposits. The river depth near this location ranged from ±40 to ±50 feet (as measured from the boat sonar). Further geologic and geotechnical work will be required to verify feasibility of this location for a raw water intake and screen.

The following makes use of this potential site solely for conceptual discussion purposes to provide a basic picture of how the regional water treatment facility might develop. The Willamette River intake could be constructed by drilling a vertical shaft on the stable area on the top of the river bluff. The vertical shaft could begin well above the 100-year flood plain, and extend below the Willamette River bottom and serve as a wetwell. A horizontal shaft could then be drilled (from the bottom of the vertical shaft) to the Willamette River, and terminated with an intake screen.

There are two conceptual alternatives developed relative to the location of the new surface WTP and associated finish water pipelines, summarized as follows. Both options include a raw water intake and pump station as summarized above.

- *Alternative 1*. The first option developed (**Figure 7-2**) consists of a raw water pump station on the river bluff near the Willamette River, which would pump raw water to a new surface WTP located just within the southeast corner of the Dayton UGB (i.e. between SE Neck Road and Hwy 221/Wallace Road). A finish water pipeline would tie directly to the Dayton distribution system, with a separate finish water pipeline to McMinnville (alignment to be determined). This option would minimize impacts to agricultural lands, and would likely be the simplest in terms of land use approvals. The proposed WTP site is undeveloped, outside of the City Limits but within the UGB.
- *Alternative 2*. The second option developed (**Figure 7-3**) consists of siting both the raw water pump station and the new WTP on the river bluff near the Willamette River. A finish water pipeline could be constructed to tie to the Dayton distribution system, with a separate finish water pipeline to McMinnville (alignment to be determined). While this option would consolidate the raw water pump station and the new WTP on a single site, it would involve significant impacts to agricultural lands located outside of the Dayton UGB.
- *Alternative 3*. The third option developed (**Figure 7-4**) consists of siting the raw water pump station on the river bluff near the Willamette River with a raw waterline to a site in or adjacent to McMinnville where the regional water treatment plant would be constructed.

For all three options the finished water intertie between McMinnville and Carlton would occur in a separate location which would be determined later.

Given the very early stage of the YRWA, we have provided this overview just to show one possible way in which the Willamette River water rights can be brought to beneficial use for the participating communities. However, development of specific recommendations and/or cost estimates for this regional surface WTP is beyond the scope of this water master plan.

VERIFY SCALE
BAR IS ONE-HALF INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

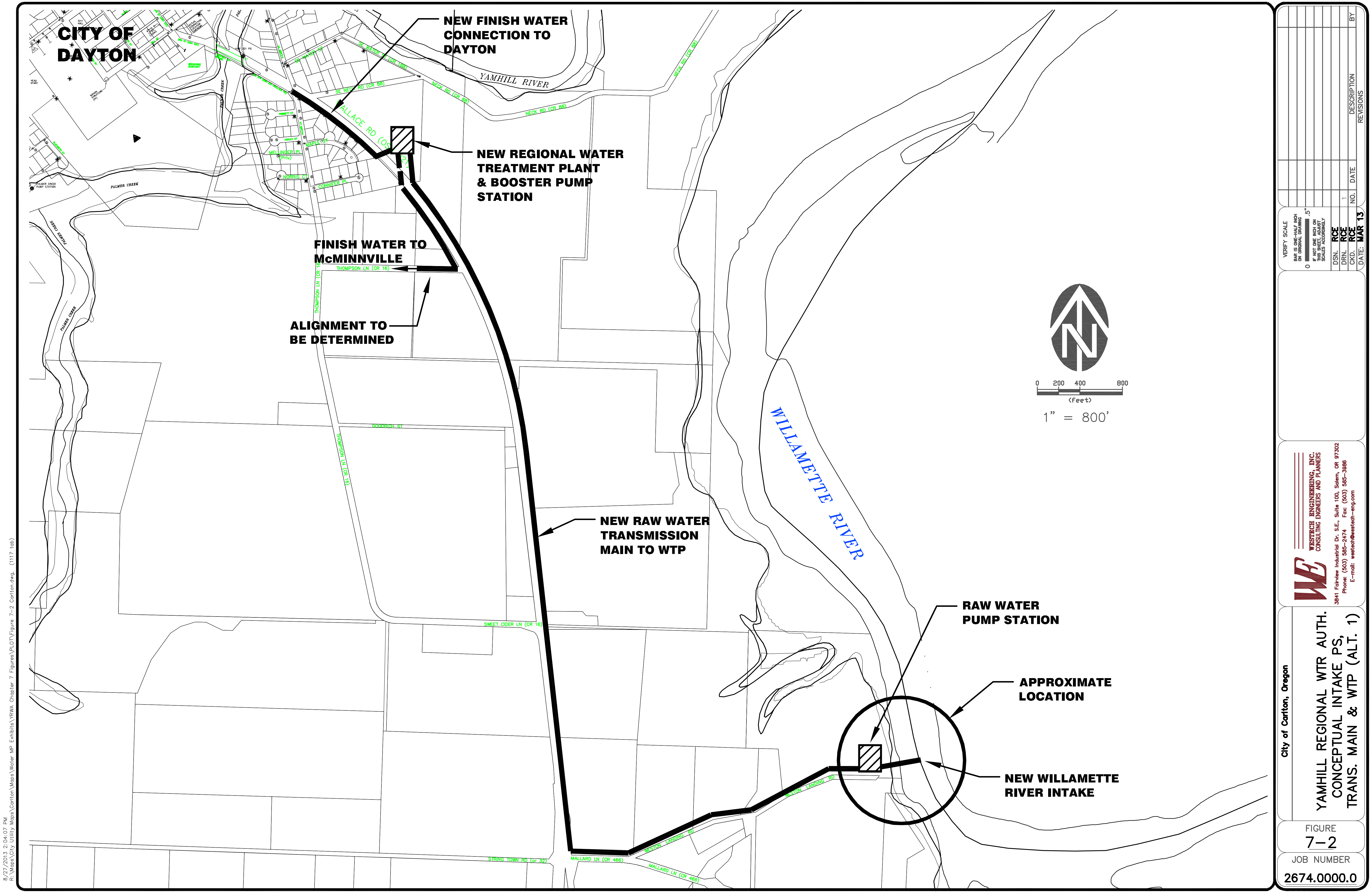
City of Carlton, Oregon

PROPOSED WILLAMETTE RIVER INTAKE LOCATION MAP

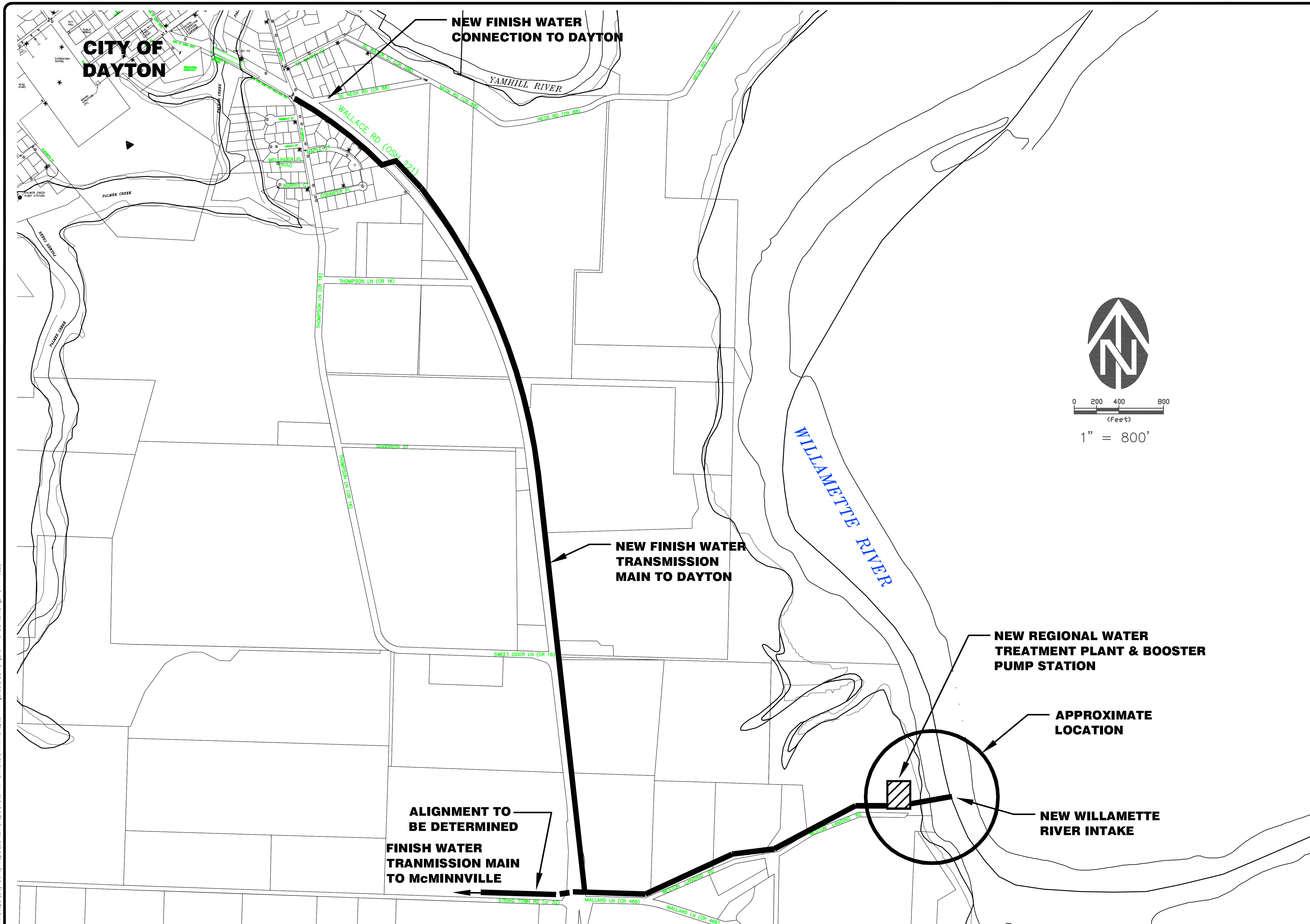
FIGURE 7-1

JOB NUMBER 2674.0000.0

8/27/2013 2:04:45 PM
R:\Maps\City Utility Maps\Carlton\Maps\Water MP Exhibits\YRWA Chapter 7 Figures\PLOT\Figure 7-1 Carlton.dwg, (1117 tab)



CITY OF DAYTON
NEW FINISH WATER CONNECTION TO DAYTON
YAMHILL RIVER
NEW REGIONAL WATER TREATMENT PLANT & BOOSTER PUMP STATION
FINISH WATER TO McMINNVILLE
ALIGNMENT TO BE DETERMINED
WILLAMETTE RIVER
NEW RAW WATER TRANSMISSION MAIN TO WTP
RAW WATER PUMP STATION
APPROXIMATE LOCATION
NEW WILLAMETTE RIVER INTAKE
0 200 400 800
(Feet)
1" = 800'
PALMER CREEK
THOMPSON LN (CR 16)
SWEET ODER LN (CR 16)
MALLARD LN (CR 466)
VERIFY SCALE
DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13
NO. DATE DESCRIPTION BY
REVISIONS
WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com
City of Carlton, Oregon
YAMHILL REGIONAL WTR AUTH.
CONCEPTUAL INTAKE PS,
TRANS. MAIN & WTP (ALT. 1)
FIGURE
7-2
JOB NUMBER
2674.0000.0
8/27/2013 2:04:07 PM



WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

City of Carlton, Oregon

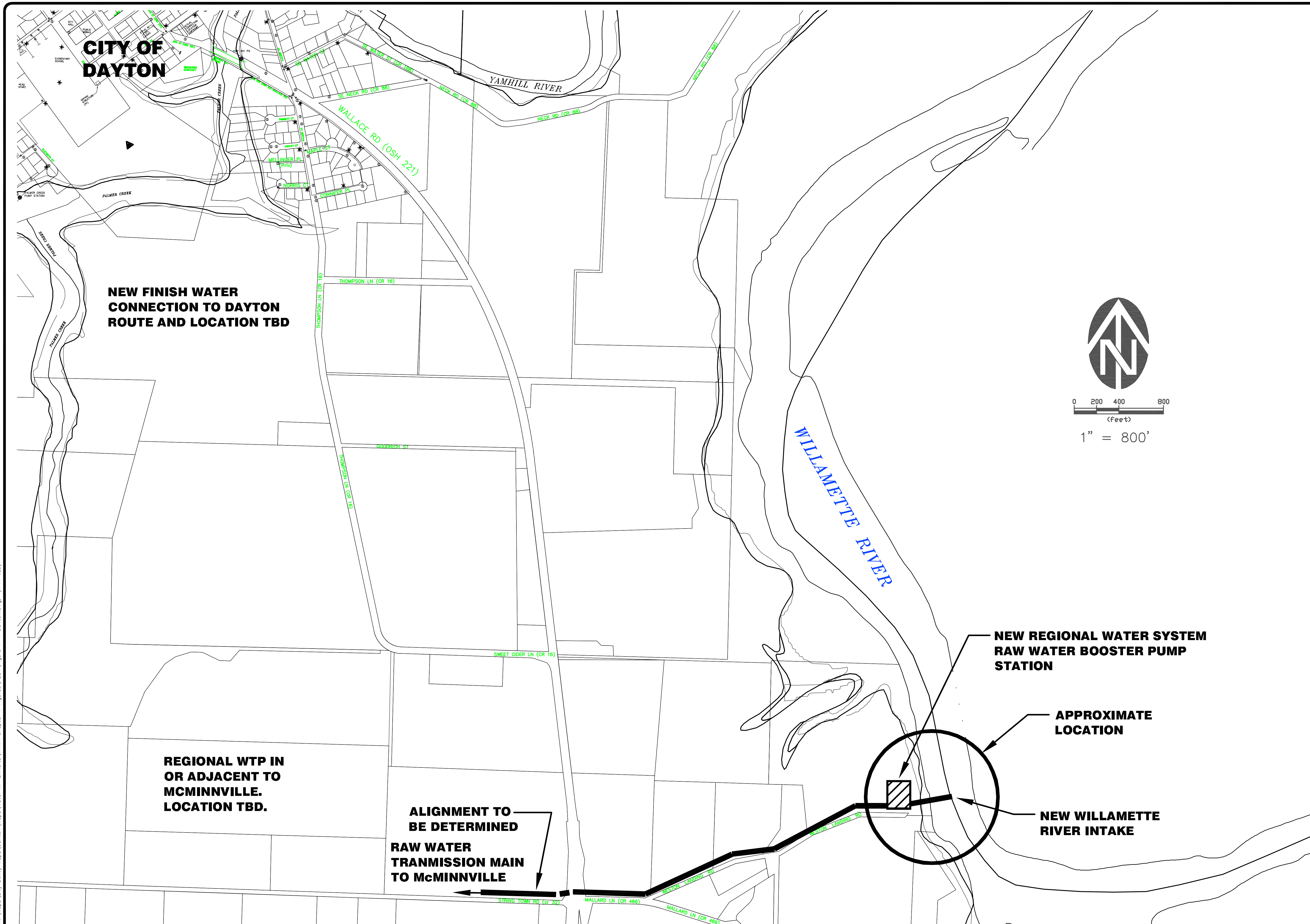
YAMHILL REGIONAL WTR AUTH.
CONCEPTUAL INTAKE PS,
TRANS. MAIN & WTP (ALT. 2)

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

FIGURE 7-3

JOB NUMBER 2674.0000.0

8/27/2013 2:03:23 PM
R:\Maps\City Utility Maps\Carlton\Maps\Water MP Exhibits\YRWA Chapter 7 Figures\PLOT\Figure 7-3 Carlton.dwg, (1117 tab)



NO. DATE DESCRIPTION BY
REVISIONS

VERIFY SCALE
BAR IS ONE-HALF INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

City of Carlton, Oregon

YAMHILL REGIONAL WTR AUTH.
CONCEPTUAL INTAKE PS,
TRANS. MAIN & WTP (ALT. 3)

FIGURE
7-4

JOB NUMBER
2674.0000.0

8/27/2013 2:05:25 PM
R:\Maps\City Utility Maps\Carlton\Maps\Water MP Exhibits\YRWA Chapter 7 Figures\PLOT\Figure 7-4 Carlton.dwg, (1117 tab)

7.6 Recommended Approaches & Improvements

At this time, and throughout the planning period, the water treatment plant appears to have capacity to produce water in sufficient quantity in conformance with current and anticipated water quality regulations and goals. No significant changes or upgrades are anticipated during the planning period.

The recommended improvements and studies are summarized in **Table 7-1** (at the end of this chapter).

7.6.1 Recoating the Clearwell

As noted above, the City should budget to repaint the clearwell during in the planning period, and if typical painting intervals are used this should occur in the next 5-10 years. The actual timeframe for painting should be based on a detailed inspection of both the exterior and interior of the reservoir by a coating specialist. It is important that painting not be delayed beyond the timeframe recommended by the coating specialist as the coating serves to protect the structural steel, and coating failures (even apparently small ones) can result in costly damage to the steel.

It is anticipated that recoating process will require this reservoir to be out of service from 60 to 90 days. Because there is no secondary or backup clearwell an alternate method of providing sufficient storage and CT time will need to be incorporated into the project.

Recommended budget numbers to cover the capital costs for the recommended improvements appear in Chapter 12. The total estimated construction cost includes work to sand blast and paint the inside and the outside of the reservoir.

7.6.2 New Tracer Study (Studies)

The current WTP production rate limitation of 473 gpm is near the rate required to produce sufficient water during periods of high demand. Having the ability to operate the plant at production rates above 473 gpm would provide the City with some useful operational flexibility. Depending on the City’s interests, it may be useful to develop a program with 2-3 allowable operating conditions depending on current water temperatures.

In order to increase the allowable flow rates through the plant a new tracer study is required. We recommend that the City work with ODWS to develop appropriate target operating conditions and then request tracer studies as required to establish flow rates and associated CT values.

7.6.3 Summary of Recommended Treatment Improvements

The following table is a brief summary of the various water treatment improvement recommendations developed by this master plan. For more details on particular projects, refer to the discussions in the body of the study.

Table 7-1 Recommended Water Treatment Improvements & Projects

Project Code	Project
WT-1	Periodic Coating Inspection of the Clearwell
WT-2	Repaint the Clearwell
WT-3	Request New Tracer Studies to Increase Allowable WTP Flow Rates

CHAPTER 8

DISTRIBUTION SYSTEM EVALUATION

Chapter Outline

DISTRIBUTION SYSTEM EVALUATION

CHAPTER 8

8.1 INTRODUCTION

This chapter evaluates the piping portion of the City's water system, including the WTP Finished Water Line, the Meadow Lake Transmission Main, and the distribution grid within town. The evaluations of this chapter include a computerized hydraulic model designed to replicate the City's transmission main and distribution network. This model was used to simulate various operational modes and fire flow scenarios in order to verify improvement recommendations. These recommendations are presented at the end of this chapter. Capital costs and a prioritized ranking of the recommendations appear in Chapter 12.

8.2 EVALUATION CRITERIA

8.2.1 Sizing and Capacity

The primary purpose of a water distribution system is to deliver the full range of consumer demands and fire flows at pressures suited for the particular use. To accomplish this, the distribution system utilizes a combination of larger transmission mains and networks of smaller distribution mains. This report will address three primary different types of waterlines:

- Finished Water Main
- Transmission Mains
- Distribution Mains

The finished water main runs from the water treatment plant to the finished water storage reservoirs.

For purposes of this evaluation, transmission mains are defined as larger diameter pipes (greater than 12-inches) designed to convey larger flows over longer distances from the point of storage to point of use.

Distribution mains are comprised of pipes 12-inches in diameter or smaller and provide connectivity throughout the service area. Distribution mains must provide both normal consumer domestic demands <u>and</u> fire flows, and thus experience a wide range of operating velocities. Distribution mains are evaluated on their ability to provide fire flow during MDD periods. The City's PWDS generally require new waterlines be a minimum of 8-inches diameter, with limited exceptions such as small cul-de-sacs where a 6-inch main may be allowed.

It should be noted that the 12-inch pipe diameter described as the dividing line between transmission and distribution pipes is not hard and fast, but rather a general guide for discussion purposes. There are a number of segments of 12-inch pipe (existing and proposed) within the in-town distribution grid which can be viewed as functioning in part as a transmission line and in part as a distribution line.

The American Water Works Association (AWWA) recommends a velocity limit of 5 feet per second (fps) for transmission mains and a maximum of 10 fps for distribution mains. The City's PWDS, by comparison, permit a line velocity of 6 fps for ADD conditions and allow a maximum of 10 fps for MDD plus fire flows. Furthermore, by general design convention, maximum head loss recommendations for transmission and distribution mains are limited to 3 and 10 feet per 1,000 feet respectively. Exceeding these head loss criteria may result in loss of hydraulic conductivity (i.e., excessive head loss). Finally, ODWS standards (OAR 333-061-0025) stipulate that water suppliers must maintain a minimum pressure of 20 psi to all service connections <u>at all times</u>, including times of peak fire flow demand.

8.2.2 System Pressure

Pressure is the primary metric for evaluating the ability of a distribution system to deliver water. Before setting forth specific recommendations or requirements regarding system pressure, it may be helpful to explain how system pressure is created and to define various terms related to system pressure.

- *Pressure and Head*. Water pressure (sometimes called head pressure) is directly related to the height to which water will rise in a standpipe at that location. Each psi of water pressure equates to 2.31 feet of water column height in a standpipe (the standpipe can be real or hypothetical). Under conditions of <u>no flow</u> through the pipelines, the water level <u>elevation</u> (in real or imaginary standpipes) will be the same at all points in a pressurized distribution system.

  To visualize this concept, imagine a lake. The water surface elevation is the same at all points. Therefore as the elevation of the ground below the lake surface changes, the height of water column above the ground (the lake bottom) changes proportionately, and the water pressure at any point at the bottom of the lake corresponds directly to the height of the water above that point. Where the lake is 23.1 feet deep the water pressure on the bottom is 10 psi, and where the lake is 231 feet deep the water pressure on the bottom is 100 psi.

- *Pressure Change with Elevation*. Based on the pressure/head concept noted above, water pressure (i.e. head pressure) will <u>increase</u> with decreasing ground elevation, and will <u>decrease</u> as the ground elevation increases.

- *Static Pressure*. As noted above, pressure in a pipeline is constant at all points in that pipeline <u>ONLY</u> when there is no flow through the pipeline, <u>AND</u> when the elevation remains the same at all points. As noted above, in a real distribution system, the static pressure increases or decreases with changing ground elevation.

- *Head Loss.* As water flows through a pipe, pressure decreases along the length of the pipe due to friction losses between the water and the pipe walls. Similar to dry friction, water friction and turbulence along a pipeline walls results in energy losses from the moving object (i.e. flowing water). When water is flowing, the energy loss is manifested as reduced pressure. When the flow stops, the friction losses also stop, and the system returns to static pressure levels.

- *Residual Pressure*. The residual pressure is the pressure measured at a point in the distribution system when water is flowing through the system. While the *static* pressure in the distribution system remains relatively constant at a given point, the *residual* pressure (i.e. the actual observed pressure) can change dramatically, depending on the flows within the system.

Based on these definitions and principles, the primary relationship of interest is the fact that pressure at any given point in the distribution system generally decreases as demand for water increases (i.e., the velocity of water through the pipes increases). Within that framework, the target minimum operating pressure utilized for peak hour demand conditions was 40 psi.

Periods of heavy fire flow demand can depress system pressures significantly. ODWS standards (OAR 333-061-0025) stipulate that water suppliers must maintain a minimum pressure of 20 psi to all service connections <u>at all times</u>, including during times of peak fire flow demand. Fire flows are typically modeled concurrent with the maximum day demand.

The Oregon Plumbing Specialty Code (OPSC) defines 80 psi as the maximum unregulated pressure for domestic water services (OPSC 608.2). System pressures above this range are to be reduced with a pressure regulating valve on the individual water service. This plan recommends maintaining normal operating pressures at their current levels, which under typical conditions range between about 60 psi and 75 psi throughout town.

8.2.3 Fire Protection

Table 5-19 in Section 5.6 details the fire flow standards adopted by the City. These standards are used in the fire flow calculations of this chapter to ensure that the distribution system is suitably sized and configured to reliably deliver the required fire flows to all areas within the city limits.

8.2.4 Deficiency Categories

In general, distribution system deficiencies fall into several general categories. Many elements of the water system may be experiencing more than one of these problems at the same time. These categories will be used to identify the deficiencies associated with particular elements of the system in the discussions of this chapter.

- *Lack of Capacity*. Undersized pipes cannot deliver peak water demands or fire flows. Although the water system may have capacity to deliver domestic flows, it is often unable to convey larger flows that may be required in an emergency. Pipes in this category have excessive head loss and create flow restrictions. This problem should be addressed either by increasing the size of the existing waterline or constructing new waterlines.
- *Lack of Facility*. Problems in this category are caused by the absence of a waterline, valve or hydrant, or inadequate looping to provide redundancy or reliability. In such cases new components should be constructed in order to increase system reliability or to simplify system operations.
- *End of Useful Life*. This category of problem is the result of old, damaged, or worn out pipes. The most common examples of this problem are leaky pipes and broken valves or hydrants. The correction of these problems requires the replacement or reconstruction of the failing component.

8.3 HYDRAULIC MODEL DEVELOPMENT

8.3.1 Model Methodology

Computerized modeling of water distribution systems is a proven and effective method for simulating and analyzing the performance of a distribution system under a wide range of operational and hydraulic conditions. A properly constructed and calibrated model permits a robust evaluation of the distribution system and often allows the designer to replicate and evaluate hydraulic scenarios that are too difficult or costly to perform in the real world. Such scenarios are useful to determine the overall strength of a distribution system and to identify weaknesses that require remediation. The evaluation of future pipeline sizes and routing can also be economically performed to assure that the expansion of the distribution system occurs in an optimized fashion.

The modeling software used for this project was WaterCAD, a commercial modeling software package developed by Bentley Systems Incorporated. This software was utilized to calculate the distribution of flow throughout the distribution network and to quantify flow rates, pressures, head losses, reservoir levels, and well pump operating points under various consumer demand patterns and fire flow scenarios.

The general methodology used in the modeling process was to examine the existing distribution grid during various demand and fire flow scenarios. Pressure, flow, or connectivity deficiencies were used to formulate improvement scenarios to remedy the problem. These scenarios were evaluated to determine their efficacy.

8.3.2 Model Development

At the most basic level the hydraulic model consists of nodes and links. Nodes represent the various elements of the system including water sources, pumps, storage tanks and pipe intersections. Links predominantly represent pipes and define the relationship between each node. The creation of the model used information from a variety of sources. The City's existing distribution system maps were used as a base in the early building stage and this information was supplemented with information from record drawings, previous engineering studies, field reconnaissance, and discussions with City staff.

Model pipe elements were constructed based on the diameter, length and material type of each pipe. Hazen-Williams roughness factors were assigned to the pipes based on the pipe material type and age. These initial roughness factors were later modified in the calibration process as described in Section 8.3.3. Model nodes were placed at pipeline intersections, near fire hydrant locations, and in locations to simulate clustered water service connections. The model nodes were populated with topographic information to ensure that elevation differences across the planning area were properly accounted for.

The 1 MG steel storage reservoir was included in the model with characteristics matching the physical geometry and elevations of the actual storage reservoir.

As typical with this type of modeling, the pipe network was simplified or 'skeletonized' to a certain degree. This process eliminated or combined short pipe segments, consolidated pipe junctions and eliminated small diameter pipes with insignificant connectivity. These simplifications were carefully conducted to ensure integrity and hydraulic equivalency with the physical distribution system.

The pipe system was also simplified in that the model only included the transmission and distribution piping downstream of the 1 MG steel storage reservoir. The key scenarios, those involving fire flow calculations, are governed by the water levels in the storage reservoirs and the characteristics of the piping downstream of the steel storage reservoir. The piping upstream of the storage reservoirs is not essential when performing these fire flow calculations.

Once the distribution network was created, the water demands established in Chapter 5 were allocated to specific nodes across the system. Demands from the larger water users were selectively modeled as discrete demands at the locations designated on the billing records.

8.3.3 Model Calibration

Model calibration is the process of adjusting model input data and structure so that the simulated hydraulic output sufficiently mirrors observed field data. Model calibration is typically an iterative process whereby the model is executed to calculate flows and pressures for all or a series of nodes in the distribution system. These results are then compared to physical measurements taken at those same nodes. Pipe roughness factors are then adjusted to increase or decrease pressures and flows and the model is re-run. This process continues until the model results converge with the measured data to an acceptable level of accuracy.

The calibration process for this model utilized flow and pressure data extracted from a variety of historical hydrant flow tests. Fire flows, as well as static and residual pressures were measured at different locations around town.

8.3.4 Model Scenarios

The calibrated model was used to investigate a number of hydraulic scenarios in the distribution system. These scenarios were evaluated using a combination of steady state and dynamic simulations. The simulations produced a snap-shot of hydraulic conditions at a fixed period in time.

In particular, the hydraulic scenarios investigated include the following under existing conditions.

- Existing peak hour demands.
- Existing maximum day demands.
- Fire flows to each model node in combination with the existing maximum day demand.

The results from the computer simulations were used to develop a list of long-range improvements required to address system deficiencies and to serve the City through the planning period. Since transmission pipelines are not well suited for incremental expansion, it is most cost effective to size the pipes for fully developed conditions.

8.4 Distribution System Analysis

The evaluation of the existing distribution system (finished water main, transmission main, and distribution mains) was performed to identify system deficiencies and possible remedies for the portion of town currently served by the existing distribution grid, as well as improvements to serve future growth-related needs. This section presents improvements for the distribution system broken down into three categories comprised of transmission, distribution and fire flow improvements. **Table 8-1** at the end of the chapter summarizes these improvements.

8.4.1 Water Treatment Plant Finished Water Line Capacity Analysis

The primary function of the Water Treatment Plant Finished Water Line is to keep the finished water storage reservoirs full. This line is currently 10-inch steel for about the first 3/4-mile, then roughly 5.75 miles of 12-inch steel to the concrete storage reservoir, followed by about 1/4-mile of 10-inch cast iron between the concrete and steel reservoirs, and finally about 400 feet of 16-inch ductile iron up the hill to the steel storage reservoir (installed when that reservoir was constructed).

For calculation purposes the head loss in a 10-inch pipe (C = 110) is approximately twice that of a 12-inch pipe (C = 100). Thus, the 1-mile of 10-inch pipe can be approximated by 2 miles of 12-inch pipe for head loss calculations. The losses in 400 ft of 16-inch pipe are negligible in these calculations. That would result in a total 12-inch pipe length of 7.75 miles, which will be rounded to 8 miles for bends, fittings, etc. The water surface elevation difference between the clearwell and the finished water storage reservoirs is about 90 feet.

Using a length of 8 miles of 12-inch pipe (C = 100) with a total head loss of 90 feet produces a flow of 700 gpm which equates to 1.01 MGD. From Table 5-16 the Maximum Day Demand at the end of the study period is 0.643 MGD.

Therefore, from a capacity standpoint the current Water Treatment Plant Finished Water Line provides sufficient capacity throughout the study period. Without attempting to predict a timeframe it is possible to estimate that the in-town population could grow to in excess of 5,000 and Maximum Day Demand would remain at levels that could continue to be served by the current sizes of pipes.

However, capacity is not the only issue facing the Water Treatment Plant Finished Water Line. As described in Chapter 5, this line is estimated to be leaking at a rate of 25-34 MG annually. This equates to a continuous average leakage rate of 50-65 gpm. This pipeline is beyond its design life and has experienced a number of recent breaks. This will be discussed further in Section 8.4.3.3 below.

8.4.2 Meadow Lake Road Transmission Main Capacity Analysis

Carlton has one true transmission main that runs from the finished water reservoirs into town along Meadow Lake Road. Within town there are a number of larger (10-12 inch) waterlines that serve a pseudo-transmission function within the distribution network. Those waterlines will be addressed in the following section on the distribution system.

The Meadow Lake Road Transmission Main has been the focus of a separate study which was summarized in a Westech Engineering Technical Memorandum to the City, which is attached as **Appendix L** to this report. Calculations for this study were carried out using the hydraulic model developed for this Water System Master Plan, resulting in a recommendation that the new transmission main be constructed using 18-inch pipe.

It is obvious from the limited fire flow currently available in town that the existing 10-inch transmission main is substantially undersized. Ultimately the question that needed to be answered was whether or not the replacement transmission main should be sized as a 16-inch or as an 18-inch line. The critical issue to be addressed was the fire flow, so the hydraulic analysis focused on a system demand based on Maximum Day Demand plus fire flow demand. From Table 5-18 the Maximum Day Demand for 2033 is estimated to be 446 gpm and from Table 5-19 the highest fire flow to be served is 3,500 gpm. These combine for a total flow of 3,946 gpm which is used in **Table 8-1** which summarizes the comparative flow velocities and head loss for the two different pipe options. Head loss is based on a total of 8,100 feet of transmission main piping.

Table 8-1 Transmission Main Performance, Segments B-E, 3,500 gpm Fire Flow

	18-inch	16-inch
Velocity (ft/sec)	5.0	6.3
Head Loss (ft [psi])	42 [18]	74 [32]

At 3,500 gpm fire flow plus MDD, the velocities are reasonable with either pipe size. With static pressures commonly above 60 psi, both pipe sizes result in a residual pressure at the town end of the transmission main that meets the 20 psi design criteria. However, using the 16-inch pipe results in a residual pressure on the order of 30 psi. At this level the additional pressure losses incurred as flow goes to the more distant areas of town become a real concern. Because of this, it was determined that the 18-inch pipe size was the better choice for this application.

For budgetary reasons the Technical Memorandum divides the Meadow Lake Road Transmission Main into five segments as presented on **Figure 8-1**. Segment A runs in Meadow Lake Road between the Concrete Reservoir and the Steel Reservoir and is not directly involved in supplying fire flows, except in the unusual case where the Steel Reservoir is out of service. The remaining four segments, B through E, run from the Steel Reservoir to the intersection of Yamhill and Main. These segments are approximately the same length, ranging from 1,750 feet for Segment E to 2,200 feet for Segment D.

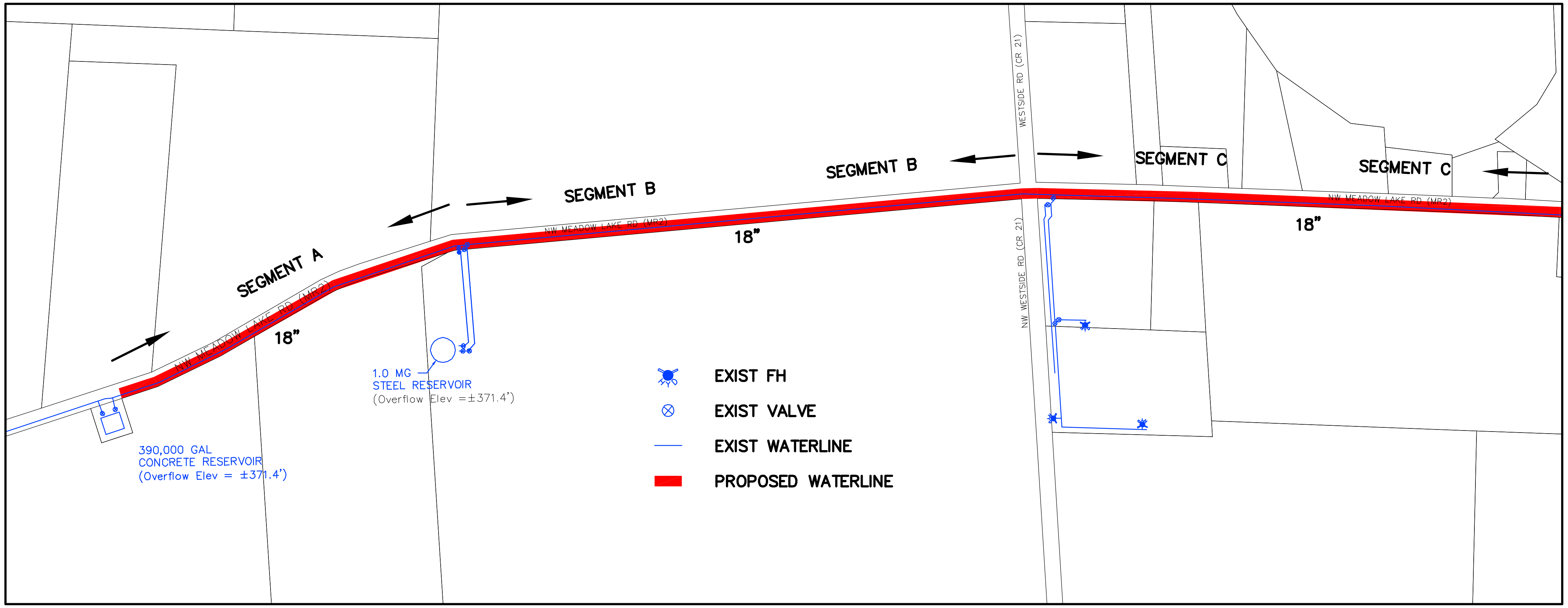
The current plan is to bring flow into town from the Steel Reservoir starting with Segment B and progressing east as funding allows. It is extremely important to note that due to the large capacity differences between the existing 10-inch and the proposed 18-inch, significant fire flow capacity will not be seen at Yamhill and Main until all four segments are completed. It is estimated that the first segment constructed will only increase fire flows in town by 100 gpm or less. The second adds only another 100 gpm or less for most of town, while the 3rd is estimated to again add roughly 100-200 gpm, depending on the location in town.

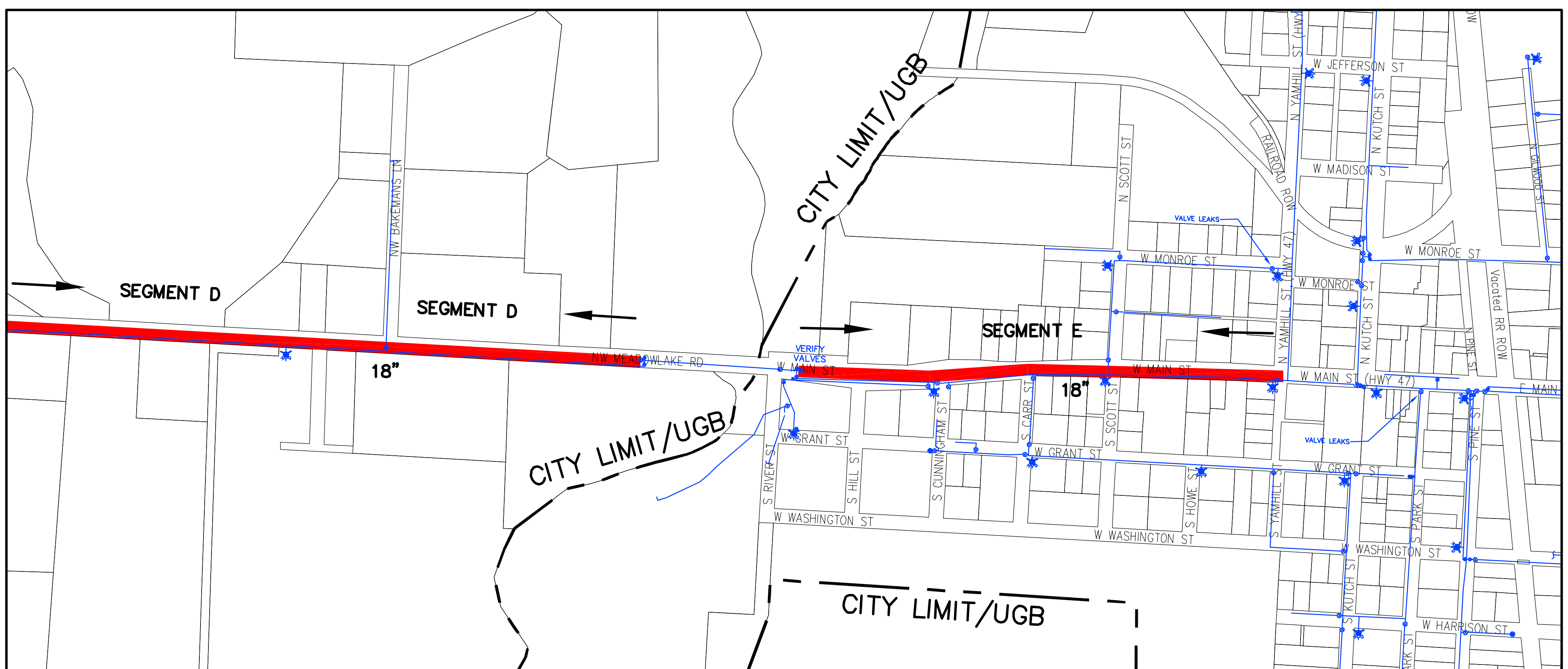
After the first three segments are constructed, it is estimated that the construction of the final segment will increase fire flows at Yamhill and Main by at least 2,000 gpm, and likely substantially more. However, despite the dramatic increases expected at Yamhill and Main as a result of the completion of Segments B through E of the Meadow Lake Road Transmission Main, many areas of town will see minimal to modest gains (on the order of a few hundred gpm) due to the limitations of the distribution system within town. These limitations will be addressed in the following section about the distribution system.

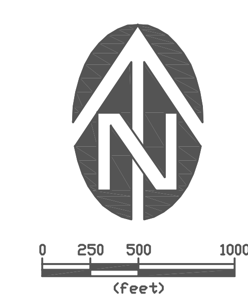
Before leaving this section on the Meadow Lake Road Transmission Main, it is important to touch on Segment A, which was briefly mentioned above. Under normal operating conditions flow goes from the Concrete Reservoir to the Steel Reservoir and then to town. Thus the primary function of Segment A is to transfer water from the Concrete Reservoir to the Steel Reservoir. Fire flow rates are not needed for this function because the largest anticipated fire flow event is a 3-hour fire at 3,500 gpm that uses 630,000 gallons. Since the Steel Reservoir holds 1 MG, it is not emptied even by the largest fire flow event. At the conclusion of the fire flow event, demand drops and the water treatment plant works to fill up the Concrete Reservoir while the Concrete Reservoir is working to refill the Steel Reservoir.

As discussed above, the maximum flow in the Finished Water Line is estimated to be on the order of 700 gpm. If a total of 630,000 gallons is taken from the Steel Reservoir and refilling occurs at a rate of 700 gpm, the time to refill is 15 hours, which is an acceptable period of time.

As a final note about the Meadow Lake Road Transmission Main, a change is needed regarding the service to 9875 Meadow Lake Road. The service for this property connects just downstream of the 0.38 MG Concrete Reservoir with an estimated pressure at the connection of ±10 psi. To provide pressure at the connection the service connection needs to be moved upstream of the Concrete Reservoir to the WTP Finished Water Line.







VERIFY SCALE
BAR IS ONE-HALF INCH ON ORIGINAL DRAWING
0 .5"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

City of Carlton, Oregon

MEADOW LAKE ROAD TRANSMISSION MAIN SYSTEM MAP

FIGURE
8–1

JOB NUMBER
2674.0000.0

If 700 gpm was the only demand placed on Segment A, an 8-inch pipe would suffice and result in flow velocities of 5 ft/sec or less. However, the potential does exist for the Steel Reservoir to be temporarily off line such that fire flows in town would need to be supplied from the Concrete Reservoir for short periods.

Since Segment A is about 1,575 feet long (much shorter than the combined length of Segments B-E), the head loss impacts are substantially less. **Table 8-2** summarizes the characteristics of 3,500 gpm flow added to a Maximum Day Demand of 446 gpm in Segment A.

Table 8-2 Transmission Main Performance, Segment A, 3,500 gpm Fire Flow

	18-inch	16-inch
Velocity (ft/sec)	5.0	6.3
Head Loss (ft [psi])	8.2 [3.5]	14.5 [6.3]

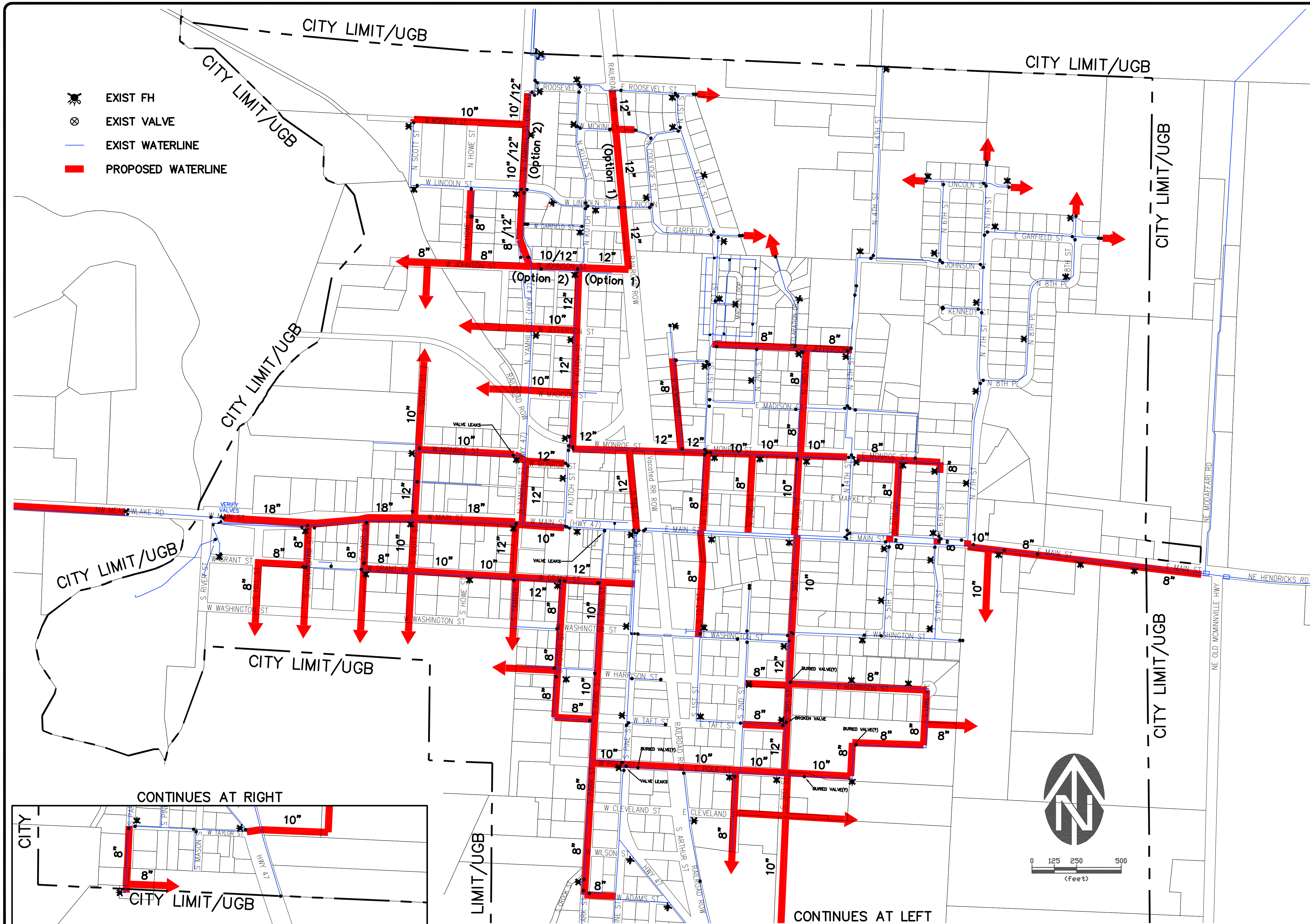
For the rare times when the Steel Reservoir may need to be taken off line, the additional 3 psi of head loss is considered acceptable such that the 16-inch becomes a suitable option for this line segment.

8.4.3 Distribution Main Capacity & Deficiency Analysis

This section evaluates the adequacy of the distribution system to deliver domestic water and fire flows to all service areas, as well as an evaluation of the adequacy of system looping, etc. Looped distribution systems are more desirable than branched systems because, coupled with sufficient valving, it allows flows to be routed around the failure of any single distribution pipe. This provides service redundancy and facilitates repair work while keeping outage areas as small as possible. A looped configuration also provides multiple water paths to any specific point in the system, which reduces velocities along any given flow path and increases the system's ability to provide high volume fire flows (assuming the looped lines are adequately sized).

The Carlton Service Level encompasses essentially all of Carlton within the City Limits, with typical pressures ranging from about 60 to 80 psi. The distribution system is fed from the Meadow Lake Road Transmission Main, with the first branching occurring at Carr and Scott Streets. Deficiencies identified in the existing distribution system are summarized below. The primary system deficiencies are fire flow related. As described above, even after the Meadow Lake Road Transmission Main is complete, many areas of town will continue to have marginal or insufficient fire flows. Due to these circumstances most of the key deficiencies are listed under the fire flow heading. However, as noted under Section 8.2.4, many elements of the water system may be experiencing more than one of the various types of deficiencies listed (lack of capacity, lack of facility, end of useful life).

Figure 8-2 shows all proposed new/replacement distribution mains regardless of deficiency category. These will be listed by deficiency category below, and grouped into priority ratings with associated costs in Chapter 12.



City of Carlton, Oregon

DISTRIBUTION MAINS
PROPOSED IMPROVEMENTS

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

VERIFY SCALE
BAR IS ONE-HALF INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

FIGURE
8-2

JOB NUMBER
2674.0000.0

8.4.3.1 Capacity Deficiencies (Fire Flows)

While the City's distribution grid is generally provides an adequate level of service for domestic flows, a number of distribution mains need to be upsized to meet the City's fire flow requirements while maintaining the required 20 psi residual at all service connections. The following distribution mains are considered essential to support fire flow requirements.

8.4.3.1.1 North Yamhill Street (Main to Monroe) – Highway 47

This is the starting point for extending fire flows from the transmission main to the north. The existing line is a 6-inch and the proposed replacement is a 12-inch. Coordination with ODOT will be required.

8.4.3.1.2 West Monroe Street (Yamhill to Kutch)

There is no existing line in this street. The proposed new size is 12-inch. This line will connect the 12-inch in Yamhill with the recently constructed 10-inch & 12-inch lines in Kutch, providing redundancy and looping in this part of town.

8.4.3.1.3 North Kutch Street (Monroe to Johnson)

The existing line is 6-inch cast iron, and the proposed replacement is 12-inch. The existing 6-inch in Kutch and a parallel, unlooped line in Yamhill provide service in this area. Increasing the Kutch distribution main to 12-inch will substantially increase fire flows to Johnson and further north.

8.4.3.1.4 West Johnson Street (Kutch to Railroad ROW)

From Johnson there are two options to extend the new, larger distribution main to the north City Limits/UGB. Option 1 runs east from Kutch to the old railroad ROW with a 12-inch, then runs in the old railroad ROW north to the City Limits/UGB as described below. The existing line in Johnson running east from Kutch is currently a dead end line.

8.4.3.1.5 Old Railroad ROW (Johnson to Roosevelt)

The old railroad ROW was recently acquired for a pedestrian and bicycle path, which also provides the potential for distribution main installation. The former railroad ROW would allow less expensive construction and avoid ODOT permitting issues. There is no waterline along this segment currently and connections at Lincoln, McKinley and Roosevelt would provide good looping and redundancy in this part of town.

8.4.3.1.6 Monroe Street (Kutch to 1st)

The current 6-inch cast iron line in Monroe is the only waterline crossing the old railroad ROW between Main Street and Johnson Street. Replacing the existing 6-inch line with a new 12-inch line will help increase fire flows in the northeastern part of town. The benefits will be modest for just this segment, but much more substantial when the segment continuing in Monroe to 4th is completed.

8.4.3.1.7 North Pine Street (Main to Monroe)

There is currently no waterline in this portion of Pine Street. Construction of a new 12-inch line here will loop the proposed 12-inch in Monroe with the existing 12-inch that runs south of Main Street in Pine Street (Highway 47).

8.4.3.1.8 South Yamhill Street (Main to Grant)

As with the line proposed to run north in North Yamhill, this new 12-inch line starts the extension of fire flows from the end of the transmission main to the southern distribution mains and is thus a critical component of extending fire flows south and southeast.

8.4.3.1.9 West Grant Street (Yamhill to Pine)

This part of West Grant is currently served by substantially undersized line 2-inch and 4-inch in size. The new 12-inch from Yamhill to Pine will extend the fire flows to the existing 12-inch in Pine Street. Since the Pine Street 12-inch continues to Washington and 3rd making this connection benefits a significant area in the southeastern part of town.

8.4.3.1.10 South 3rd Street (Main to Polk)

This entire stretch of South 3rd is currently a 6-inch cast iron line. The proposed improvements include a 10-inch from Main to Washington and a 12-inch from Washington to Polk. The reason for the larger line south of Washington is the extension of the 12-inch main in Washington south to the School.

8.4.3.1.11 South Carr Street (Main to Grant)

There is currently a 4-inch cast iron line in this part of Carr Street. By replacing it with an 8-inch line this extends fire flow down from the transmission main down to Carr Street where it can run west in an 8-inch line and east into the grid.

8.4.3.1.12 West Main Street (Yamhill to Kutch)

The existing line is 8-inch cast iron to be replaced by a 10-inch line. This will extend the fire flows from the transmission main east in Main Street to connect to the new 10-inch line in Kutch Street. This will supplement fire flows by creating a secondary path as well as provide redundancy.

8.4.3.1.13 West Madison Street (Yamhill to Kutch)

West Madison Street does not have any waterline in this block. The proposed new 10-inch line is intended to extend fire flows from the proposed 12-inch distribution main in Kutch over to Yamhill. The 12-inch distribution main is to be constructed in Kutch to avoid the additional construction costs and administrative requirements of working in a State Highway. By extending the 10-inch to Yamhill the fire flow objective is met without State Highway construction.

8.4.3.1.14 West Jefferson Street (Yamhill to Kutch)

See above for the discussion for West Madison Street (Yamhill to Kutch).

8.4.3.1.15 West Johnson Street (Kutch to Howe)

As discussed above there are two options for extending fire flows north from Johnson to the City Limits/UGB. The current expectation is that Option 1 will be pursued. Should this prove true fire flow still needs to be extended west to Yamhill Street and on to Howe to serve an area that is currently poorly served or not served at all with regard to fire flow.

8.4.3.1.16 North Yamhill Street (Roosevelt to McKinley)

Assuming the Option 1 12-inch line is constructed in the old railroad ROW, this 10-inch line will connect to the existing 12-inch line at the intersection of Roosevelt and Yamhill and extend fire flow south to McKinley (which currently does not have any distribution main), thus setting the stage for the project described below.

8.4.3.1.17 West McKinley Street (Yamhill to Scott)

As just noted above, West McKinley Street currently does not have a distribution main. The construction of the proposed 10-inch distribution main would result in a connection with the existing 8-inch line at the north end of Scott thereby looping the industrial area with 8-inch and 10-inch lines providing a substantial increase in fire flows to this area.

8.4.3.1.18 East Monroe Street (1st to 4th)

From 1st Street to 3rd Street the existing line is 6-inch cast iron, then between 3rd and 4th it is 4-inch of unknown material. This entire segment is proposed to receive new 10-inch distribution main. This will connect the proposed 12-inch line coming from Kutch east to the existing 10-inch line in 4th.

8.4.3.1.19 North 3rd Street (Main to Monroe)

The existing line is only 2-inch PVC, which is extremely undersized. Installing the proposed 10-inch in this location will help carry flow from Kutch to 3rd and Main, providing an additional supply for the line running south to the Elementary School.

8.4.3.1.20 South Park Street (Grant to Polk)

From Grant to Harrison the existing line is 2-inch galvanized, undersized and prone to leaks. From Harrison to Polk the line is 4-inch cast iron, still substantially undersized and also old and subject to leaking. The replacement 10-inch line will provide much needed flow capacity south on Park Street, which is one of the least well served areas in town with regard to fire flow.

8.4.3.1.21 Polk Street (Park to southeast of the Elementary School)

Between Park and 3rd the existing line is 4-inch cast iron, and from 3rd Street to the fire hydrant southeast of the school it is 4-inch PVC. Connecting the proposed 10-inch in Park with the school area provides a third primary route for fire flows to get from the transmission main to the school, with the 12-inch in Washington and the 10-inch in 3rd Street being the others. All of this distribution main infrastructure is necessary to eventually meet the demanding fire flow requirements at the school.

8.4.3.2 Lack of Facility and Looping Deficiencies.

Once all of the distribution main improvements described above are complete the City can anticipate substantially better fire flows in all areas of the town. The proposed additional distribution mains presented in this section are generally intended to provide looping and redundancy to allow better fire flows to be available even if other key distribution mains need to be taken out of service.

8.4.3.2.1 South Cunningham Street (Main to Grant)

No distribution main currently exists. An 8-inch line is proposed.

8.4.3.2.2 West Grant Street (Cunningham to River)

No distribution main currently exists. An 8-inch line is proposed.

8.4.3.2.3 South Scott Street (Main to Grant)

No distribution main currently exists. A 10-inch line is proposed.

8.4.3.2.4 West Grant Street (Carr to Yamhill)

The existing line is 4-inch cast iron. An 8-inch line is proposed from Carr to Scott and a 10-inch line is proposed from Scott to Yamhill.

8.4.3.2.5 South Kutch Street (Grant to Taft)

From Grant to Harrison the existing line is 4-inch cast iron and from Harrison to Taft the existing line is2-inch of unknown material. The proposed line is 8-inch.

8.4.3.2.6 West Taft Street (Kutch to Park)

The existing line is 2-inch galvanized and the proposed line is 8-inch.

8.4.3.2.7 South Park Street (Polk to Adams)

The existing line is 4-inch cast iron. An 8-inch line is proposed.

8.4.3.2.8 West Monroe Street (Scott to Yamhill)

The existing line is 6-inch cast iron. A 10-inch line is proposed.

8.4.3.2.9 North Yamhill Street (Johnson to McKinley)

As discussed above the current expectation is that Option 1 will be constructed such that the primary fire flow route will be in the old railroad ROW between Johnson and Roosevelt. If that occurs the need to work in the Highway ROW is delayed (but not completely eliminated), since the current lines are 4-inch cast iron and steel. At such time as they are replaced under an Option 1 scenario, the proposed line is an 8-inch from Johnson to Lincoln and a 10-inch from Lincoln to McKinley.

8.4.3.2.10 North Howe Street (Johnson to Lincoln)

There is currently only a 2-inch in the northern part of this block and no line in the southern part. The proposed line is an 8-inch running the full length of the block.

8.4.3.2.11 North Gilwood Street (Monroe to 4-inch Loop Line)

The existing line is 4-inch cast iron. An 8-inch line is proposed.

8.4.3.2.12 East Jefferson Street (1st to 4th)

The existing line is 6-inch PVC. An 8-inch line is proposed.

8.4.3.2.13 North 3rd Street (Monroe to Jefferson)

The existing line is 6-inch PVC. An 8-inch line is proposed.

8.4.3.2.14 North 5th Street (Main to Monroe)

The existing line is 2-inch PVC. An 8-inch line is proposed.

8.4.3.2.15 East Monroe Street (4th to 6th)

The existing line is 4-inch of an unknown material. An 8-inch line is proposed.

8.4.3.2.16 Main Street Connections (5th and 6th Street Intersections)

There is a 10-inch ductile iron line on the north side of Main Street and a parallel 6-inch cast iron line on the south side of the street from Pine to 7th. The proposed connections allow these lines to share east-west flow and to pass north-south flow across Main Street, providing redundancy and better looping in this area.

8.4.3.2.17 East Harrison Street (2nd to Linke)

There is currently no line between 2nd and 3rd while the existing line between 3rd and Linke is 4-inch cast iron. The proposed line is 8-inch.

8.4.3.2.18 South Linke Avenue and Elementary School Loop (Harrison to Polk)

The existing line is 4-inch cast iron and PVC. An 8-inch line is proposed.

8.4.3.2.19 East Taft Street (2nd to 3rd)

The existing line is 6-inch AC. An 8-inch line is proposed. An additional benefit from this project is to remove the AC pipe from the system.

8.4.3.3 End of Useful Life

As existing pipes and valves near the end of their useful life, they should be replaced before failure occurs. Depending on several factors, it can be reasonably assumed that even new waterlines (PVC or ductile iron) will have a 75 year service life. Many older pipe materials have even shorter life spans, which means that planning and budgeting should anticipate replacing most existing pipes that are currently 50 years old or older, or less where experience indicates recurring problems.

Due to the extensive list of projects already listed in the section above, many old pipes will be replaced as those projects occur. However, the City should be aware that even after all fire flow related projects and looping related projects are completed there will still be many old and/or undersized pipes remaining in the system. These pipes should be replaced as opportunity or need arises, such as with street improvement projects or when leaks in a given line become common or excessive. In some cases an older line may run parallel to a new line in the same section of street. Where this occurs, as the overall distribution grid is built up, it may be feasible and appropriate to take the older line out of service without replacing it.

The following is a listing of pipes that fit within the old and/or undersized category that are candidates for replacement or removal. Where replacement is needed the normal size should be 8-inch unless circumstances warrant further evaluation resulting in the selection of different size. This list while extensive, may not be 100% complete.

- North Yamhill Street (Monroe to Main), 6-inch Cast Iron
- North Gillwood to North 1st Loop Line, 4-inch Cast Iron
- North Jefferson Street (1st to Declaration), 6-inch Steel
- North Jefferson Street (Declaration to 4th), 3-inch Steel
- North 3rd Street (Monroe to Jefferson), 4-inch Cast Iron

- East Madison Street (West of 3rd), 2-inch PVC
- East Madison Street (East of 3rd), 6-inch Unknown Material
- North 6th Street (Main to Monroe), 6-inch Cast Iron and 4-inch Cast Iron
- East Main Street (Pine to 7th), 6-inch Cast Iron
- South Park Street (Main to Scott), 6-inch Unknown Material
- South Washington Street (Yamhill to Kutch), 2-inch Unknown Material
- South Pine Street (Main to Washington), 6-inch Cast Iron
- West Harrison Street (Kutch to Park), 4-inch Cast Iron
- Highway 47 (Polk to Taylor), 6-inch Cast Iron
- South Park Street (Adams to Taylor), 4-inch Cast Iron
- South Pine Street (Wilson to Taylor), 4-inch Unknown Material
- West Taylor Street (Park to Highway 47), 6-inch Cast Iron
- South Mason Street (South of Taylor), 6-inch Cast Iron
- East Washington Street (1st to 2nd), 4-inch Unknown Material
- East Washington Street (2nd to 3rd), 4-inch PVC
- South 2nd Street (North of Washington), 4-inch Unknown Material
- South 2nd Street (Washington to Polk), 6-inch Unknown Material

8.4.3.4 Lack of Isolation Valves

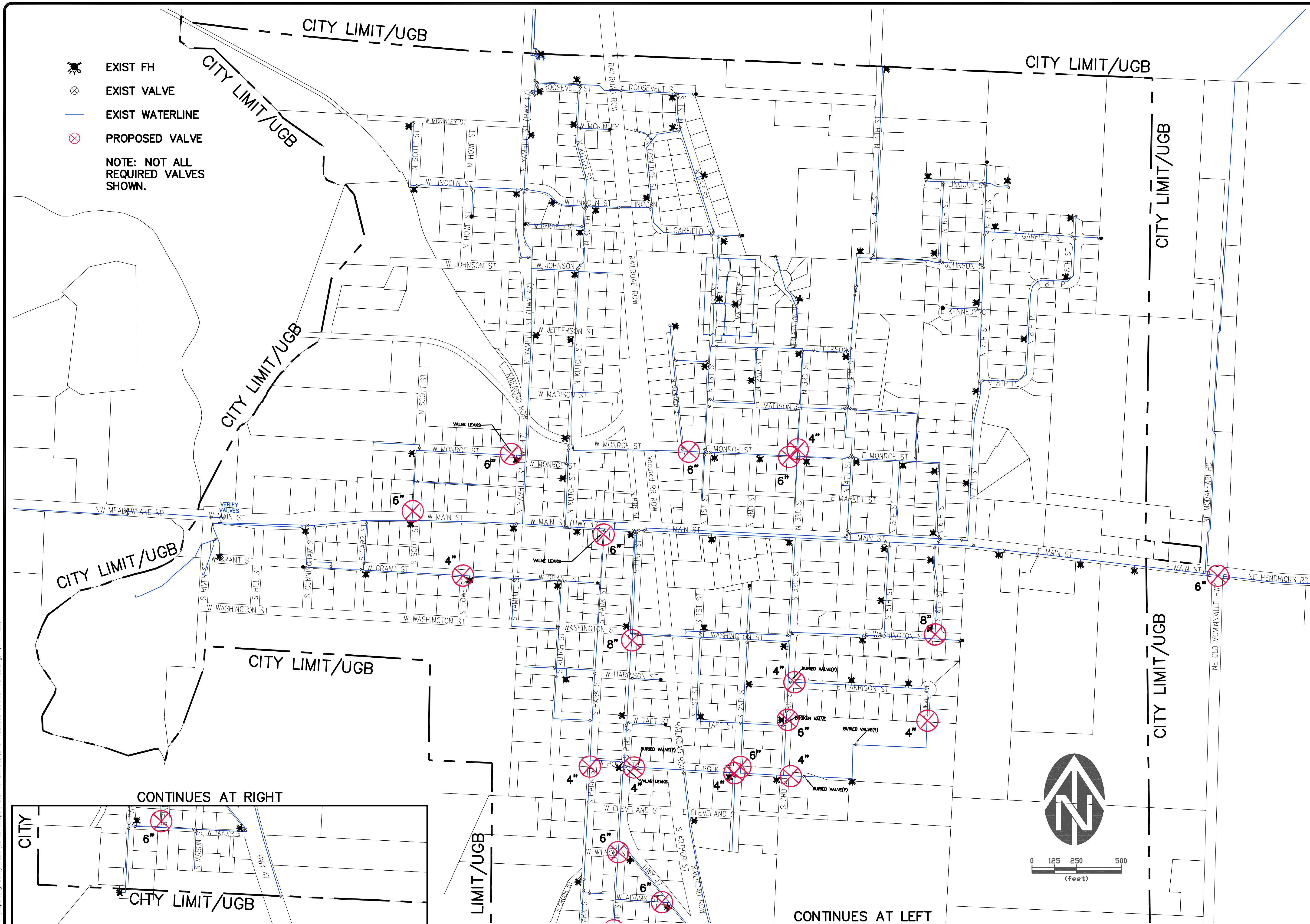
The City's distribution system is currently lacking sufficient isolation valves to allow reasonable operation of the system when a portion of the system must be shut down, such as for maintenance or to repair a leak. Thus, when a portion of the distribution system must be shut down a significant part of town must be included affecting many more residents and/or businesses than should be necessary.

In order to reduce the size of areas affected by waterline shut downs the City desires to install a number of new isolation valves into the distribution grid. **Figure 8-3** shows the tentative locations for proposed new isolation valves.

8.4.3.5 Upgrades to Water Services, Private Waterlines and Backflow Devices

Due to the age of the Carlton water system, many of the water service connections date back many decades. As mainlines are reconstructed or replaced, current City policy requires that the water service lines between the mainline and the water meter be replaced as part of the project. The portion of the water service line beyond the water meter is the responsibility of the property owner. The property owner has a major incentive to repair leaks because he is responsible to pay for any water that passes through the meter.

Many of the water services were also installed prior to the implementation of the State Cross Connection Control Program (i.e. backflow prevention). As previously noted, the City currently has a State certified cross connection control specialist on staff.



City of Carlton, Oregon

PROPOSED ADDITIONAL ISOLATION VALVE LOCATIONS

FIGURE 8-3

JOB NUMBER 2674.0000.0

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

VERIFY SCALE
BAR IS ONE-HALF INCH ON ORIGINAL DRAWING
0 ½"
IF NOT ONE HALF INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

9/4/2013 3:05:57 PM
R:\Maps\City Utility Maps\Carlton\Maps\Water MP Exhibits\8-3 Proposed Isolation Valves.dwg. (1117 tab)

8.4.3.5.1 Private Waterlines & Rural Waterlines

In some cases, there are private waterlines serving multiple water uses or properties. Current City policy requires a master water meter and backflow device on these lines near the mainline connection, and that payment for maintenance, repairs and any water leakage downstream of the meter is the responsibility of the property owners. The City's goal is to eventually bring all private services into conformance with current policy. The following areas are of interest to the City with regard to these concerns.

- Modaffari Lane Water Services (meter but no backflow device)
- East Carlton Water Company (no meter or backflow device)
- 9140 Highway 47 Water Service (no meter or backflow device at the City Limits)
- Bakemans Lane Water Services (no meter or backflow device at the main)

8.4.3.5.2 Cross Connection Control

As existing water services without adequate backflow preventers are identified, we recommend that the City continue their policy and program of requiring the property owners to install backflow devices meeting state standards, and to test these devices annually as required. The following is not an inclusive list.

Recommended improvements to address distribution system deficiencies are summarized in Section 8.5.

8.4.4 Water Loss Evaluation

A detailed evaluation of the water losses (leakage & unaccounted-for water) from the distribution system is contained in Section 5.4.7. As noted under Section 6.7.1, reduction of distribution system losses will be equivalent to developing new sources that increase the available water supply. As noted under Section 9.4.1, reduction of distribution system losses will decrease the storage volume required for equalization and standby storage. As noted in Chapter 7, reduction of distribution system losses will reduce the requirements on the water treatment system. As such, the City should consider the reduction of water losses as a major priority, as it will result in significant benefits to all four areas of the water system (source, treatment, distribution and storage).

8.4.5 Water Age Evaluation

Water quality is emerging as a major concern for many utilities. An important indicator of water quality is the age of the water in the pipes, also known as the hydraulic residence time. Based upon a survey of 800 utilities, an AWWA publication reported an average distribution system retention time of 1.3 days, with a maximum retention time of 3.0 days. Examples of much longer retention times in portions of water supply systems have been reported. Water retention time is primarily a function of water demand, system operation, and system design. Water quality can change as it moves between sources of supply and treatment to the consumer. While there is no set requirement for minimum or maximum water age, utilities should be cognizant of their system's water age because elevated water age can lead to taste and odor complaints, increases in temperature, increases in disinfection byproducts, decreases in disinfection residual, and other water quality issues. The appropriate water age for any particular system is a function of the age and material of the pipes, the type of disinfection utilized (chloramines versus chlorine), and the amount of organic matter in the system. The configuration of the City's existing distribution system does not raise concerns about excessive water age.

8.4.6 Distribution Improvements for Developments

Outside of large diameter transmission lines, the expansion of the distribution grid to serve new developments is anticipated to occur in areas selected by developers. In such cases the City's PWDS provides a sound basis for ensuring that a properly sized and looped grid is constructed around the larger diameter transmission mains. Beyond this, localized distribution improvements will be evaluated on a case by case basis. For the above reasons, these projects are not included in the water systems project list.

8.5 Summary Of Recommended Distribution Improvements

Several improvement projects have been identified based on the capacity deficiency analyses presented in this chapter. Transmission line improvements make up a significant portion of the work. Distribution projects have been identified to improve a combination of capacity and age deficiencies. Other improvement projects have been identified to strengthen fire flows, system redundancy and provide additional connectivity between the WTP and distribution grid. These improvement recommendations are summarized in **Table 8-3**. This table does not include replacement of all of the small diameter lines or all waterlines that may be required as part of individual developments.

Recommended budget numbers and prioritization of these projects is presented in Chapter 12.

Table 8–3 Recommended Transmission/Distribution Improvements & Projects

Project Code	Location	Extg φ (inch)	New φ (inch)	Length (feet)
	Treatment Plant Finished Water Line			
F-1	Finished Water Supply Line Contingency Reserve			
F-2	WTP Finished Water Line (WTP to Concrete Reservoir)	8 Stl	12	34,500
	Transmission System(*generally listed west to east*)			
T-1	Concrete Reservoir Valve Improvements			
T-2	Meadow Lake Road Transmission Main Segments B-E (Meadow Lake Road at Steel Reservoir to North Yamhill, Excluding the Bridge)	8/10 CI	18	8,130
T-3	Meadow Lake Road Transmission Main Segment A (Meadow Lake Road from the Concrete Reservoir to the Steel Reservoir)	10 CI	18	1,575

Project Code	Location	Extg φ (inch)	New φ (inch)	Length (feet)
	Distribution System (*generally listed north to south, west to east*)			
D-1	North Kutch Street (Monroe to Madison)	6 CI	12	300
D-2	West Monroe Street (Yamhill to Kutch)	-	12	240
D-3	Monroe Street (Kutch to Pine)	6 CI	12	300
D-4	North Yamhill Street (Main to Monroe)	6 / 6 CI	12	450
D-5	North Pine Street (Main to Monroe)	-	12	450
D-6	West Main Street (Yamhill to Kutch)	8 CI	10	240
D-7	South Yamhill Street (Main to Grant)	-	12	300
D-8	West Grant Street (Yamhill to Pine)	4 CI / 2 PVC	12	650
D-9	South 3rd Street (Main to Polk)	6 CI	10	1,350
D-10	Railroad ROW (Johnson to Roosevelt)	-	12	1,000
D-11	West Johnson Street (Kutch to Railroad ROW)	6 CI	12	250
D-12	North Kutch Street (Madison to Johnson)	6 CI	12	700
D-13	East Monroe Street (1st to 4th)	6 CI / 4	10	820
D-14	North 3rd Street (Main to Monroe)	2 PVC	10	450
D-15	Monroe Street (Pine to 1st)	6 CI	12	440
D-16	North Yamhill Street (Roosevelt to McKinley)	4 STL	10, 12	200
D-17	West McKinley Street (Yamhill to Scott)	-	10	600
D-18	West Johnson Street (Kutch to Howe)	6 Stl	8, 10, 12	670
D-19	West Jefferson Street (Yamhill to Kutch)	-	12	240
D-20	West Madison Street (Yamhill to Kutch)	-	10	250
D-21	South Cunningham Street (Main to Grant)	1 C	8	200
D-22	West Grant Street (Cunningham to River)	-	8	500
D-23	South Carr Street (Main to Grant)	4 CI	8	280
D-24	South Scott Street (Main to Grant)	-	10	290
D-25	South Park Street (Grant to Polk)	2 GALV	10	1,000
D-26	Polk Street (Park to Southeast of the Elementary School)	4 CI / 4 PVC	10	1,450
D-27	East Harrison Street (2nd to Linke)	4 CI	8	1,000
D-28	South Linke Avenue and Elementary School Loop (Harrison to Polk)	4 CI	8	900
D-29	South Park Street (Polk to Adams)	4 C	10	740
D-30	West Adams Street (Park to Pine)	-	8	200
D-31	West Grant Street (Carr to Yamhill)	4 CI	8, 10	830

D-32	North Yamhill Street (Johnson to McKinley)	4 STL / CI	8, 10	800
D-33	North Howe Street (Johnson to Lincoln)	2	8	450
D-34	North Gilwood Street (Monroe to 4-inch Loop Line)	4 CI	8	500
D-35	East Jefferson Street (1st to 4th)	6/3 STL	8	800
D-36	North 3rd Street (Monroe to Jefferson)	4 CI	8	600
D-37	West Monroe Street (Scott to Yamhill)	6 CI	10	620
D-38	East Monroe Street (4th to 6th)	4	8	450
D-39	North 1st Street (Main to Monroe)	2 GALV	8	450
D-40	North 2nd Street (Main to Monroe)		8	450
D-41	North 5th Street (Main to Monroe)	2 PVC	8	450
D-42	Main Street Connections (5th and 6th Street Intersections)	-	8	120
D-43	South Kutch Street (Grant to Taft)	2 / 4 CI	8	777
D-44	West Taft Street (Kutch to Park)	2 GALV	8	200
D-45	East Taft Street (2nd to 3rd)	6 PVC / 6 AC	8	250
D-46	North Scott Street (North of Monroe)		10	600
D-47	North Scott Street (Monroe to Main)		12	400
D-48	South 1st Street (Main to Washington)		8	600
D-49	East Taylor Street (East of Arthur)		10	400
D-50	South Park Street (South of Taylor)	4 CI	8	400
D-51	East Main Street (7th to Modaffari)	6 CI	8/10	1300
D-52	South 3rd Street (South of Polk Street)		10	950
	Interim Isolation Valve Improvements		Quantity	
V-1	Added 4-inch Interim Isolation Valves, Various Locations		8	
V-2	Added 6-inch Interim Isolation Valves, Various Locations		11	
V-3	Added 8-inch Interim Isolation Valves, Various Locations		2	
	East Carlton Water Company Water Meter and Double Check			
M-1	Install New Master Meter and Double Check			

CHAPTER 9

WATER STORAGE EVALUATION

Chapter Outline

FINISHED WATER STORAGE EVALUATION

9.1 INTRODUCTION

The emphasis of this chapter is shifted from the existing water storage inventory of Chapter 4 and placed on the design and performance of existing and future finished water reservoirs.

Although closely integrated with the overall water distribution system as discussed in Chapter 8, this chapter presents finished water storage as a separate discussion to focus on several key issues unique to this subset of the distribution system. Recommended budget numbers to cover the capital costs for the recommendations presented in this chapter appear in Chapter 12.

Because finished water storage only serves demand (consumption and losses) east of the storage reservoirs, the values in **Table 5-16** need to be adjusted to reflect this fact. **Table 9-1** presents demand data for flows leaving the Steel Storage Reservoir heading to town.

Table 9-1 Summary of Projected Water Demands, Flow from Steel Reservoir

Year	2012	2015	2020	2025	2030	2033
Population	2065	2080	2247	2465	2669	2801
Avg. Day Demand (ADD)						
MGD	0.223	0.224	0.236	0.251	0.266	0.276
(gpm)	155	155	164	175	185	191
Max. Day Demand (MDD)						
MGD	0.407	0.409	0.434	0.466	0.497	0.516
(gpm)	283	284	301	324	345	358
Peak Hour Demand (PHD)						
(gpm)	651	655	696	751	802	835

9.2 EVALUATION CRITERIA

Per ODWS rules, engineers are responsible for planning and designing stable and durable reservoirs that meet demands and protect the quality of stored water. Some of the evaluation criteria used utilized in the analysis and recommendations of this chapter are discussed below.

9.2.1 Storage Volume Categories

The primary function of water storage is to provide a reserve of water to equalize daily variations between supply and consumer demand, to serve fire-fighting needs, and to meet system demands during an emergency interruption of supply. The overall storage within a system can be divided into the several categories. The following sub-paragraphs define these storage allocation categories. Evaluation of how these categories apply to the Carlton water system are discussed in Section 9.3.

9.2.1.1 Operational Storage

Storage volume within the upper elevation of a reservoir used by the system operators to control the start and stop of the sources or pumps which fill the reservoir. The operational storage volume is not counted as part of the "effective storage" volume (discussed below), since emergency conditions are as likely to begin when water level is at the bottom of the operational storage range as when it is at the top of the range. The overall elevation difference (storage volume) required by the pump control system is determined by the type of instrumentation, the number of sources or pumps that fill the reservoir, and operator preferences.

9.2.1.2 Equalization Storage

Storage that is utilized to meet short term consumer demands that exceed the production capacity of the supply sources. As previously discussed, water demands vary throughout the day based on the water use patterns of the community, as well as over multiple days. Demand fluctuations are influenced the relative mix of residential, commercial and industrial use, as well as by the weather. Commercial and light industrial use tends to be relatively constant through the normal daytime hours (with light to no use at night), while residential use fluctuates between relatively high flows in the morning, low flows during the day, higher flows in the evening, and lowest flows at night. The equalization storage volume required is typically determined by one of two methods, as follows.

(1) The first method utilizes a percentage of the maximum day demand (MDD), generally 20 to 40%.

(2) The second method is to determine the deficit between the peak hour demand (PHD) and the available supply for a determined duration, typically 2 to 4 hours.

9.2.1.3 Standby Storage (Emergency Storage)

Storage that is required to meet demand during emergency situations such as power outages, supply pipeline failures or natural disasters (often termed as emergency storage). The amount of emergency storage provided can be highly variable depending upon the reliability and diversity of supply sources, an assessment of risk and the desired degree of system reliability.

Water systems served by a single source should have Standby Storage volume of twice the water system's Average Day Demand for the design year available to all service connections at 20 psi. Generally, water systems should consider additional Standby Storage volume for surface water sources vulnerable to flooding or other extreme weather events. For the purposes of this study the Carlton water system was considered to not be especially vulnerable to flooding or other extreme weather events.

9.2.1.4 Fire Suppression Storage

Storage that is required to satisfy the largest design fire flow demand in the system. Fire storage volume is calculated by multiplying the design fire flow rate by its required duration. For a given fire flow, the Oregon Fire Code stipulates a required design duration (OFC Table B105.1).

9.2.1.5 Dead Storage

The volume of unusable water stored in a reservoir that either cannot be withdrawn, or which lies below the minimum recommended operating level of the reservoir (i.e. the minimum level required to maintain required suction pressure on pumps, etc). Dead storage that is not available without violating the recommended operating conditions of distribution or fire pumps cannot be counted for the purposes of water storage planning (even if it is physically possible to use this water). There is no Dead Storage in the Carlton finished water storage reservoirs.

9.2.1.6 Pumped Storage

In some water systems there is stored water that lies below the normal hydraulic head level of the distribution system (i.e. in ground storage reservoirs). This is water that must be pumped into the distribution system or into an elevated reservoir before it is available in the distribution system. If the pumps (which move this stored water into the distribution system) are not available during an emergency, the pumped storage water is also unavailable. There is no pumped storage in the Carlton water system.

9.2.1.7 Effective Storage

As noted above, the total volume is a reservoir often does not equal the effective volume available to the water system. The effective storage volume is defined as the reservoir volume below the bottom of the operational storage level, minus any dead storage. In the case of Carlton, since there is no dead storage the effective storage is the total storage reduced by the operational storage.

9.2.2 System Pressure

In most municipal distribution systems, including Carlton, the service pressure is determined by the elevation of the free water surface in the storage reservoirs serving the system. Service pressures at the point of delivery typically range from 40 to 80 psi. Pressures below this range may cause inaccuracies in customer meters and flow reductions during periods of high demand whereas pressures above this range can damage domestic plumbing systems. The Oregon Plumbing Specialty Code (OPSC) defines 80psi as the maximum unregulated pressure for domestic service. Service pressures above this range must be reduced with a pressure regulating valve. This plan recommends maintaining the operating pressure range in town between 40 and 80 psi.

9.2.3 Water Quality

There are no specific regulatory requirements for water turnover rates in storage facilities, but industry sources suggest a complete water turnover be accomplished every 3 to 5 days. Experiences with reservoirs with cement-based internal surfaces suggest a slightly slower turnover rate of 5-7 days.

Historically water storage facilities are operated at near full levels to maintain system pressure and maximize storage volumes for emergencies; however, in times of non-emergency the large storage volumes reserved for firefighting can create water quality problems. Degraded water quality in storage facilities is frequently the result of under utilization and poor mixing during filling cycles. As water ages, there is also a greater potential for disinfection by-product (DBP) formation.

In summary, excessive water age can result in a diverse set of problems ranging from the loss of residual disinfectant, problems with bacterial proliferation or re-growth, increased formation of DBPs, taste and odor problems, as well as temperature and pH instabilities.

9.2.4 Reliability of Pumped Storage

Clearly, the provision of emergency backup power and redundant pumping is critical for systems that rely heavily on pumped storage. Since Carlton does not rely on pumped storage this factor is not of concern for this analysis.

9.2.5 Redundancy

A lack of redundancy with regard to storage facilities is most frequently encountered when a reservoir must be taken off-line for cleaning, inspection or maintenance. While some of these procedures can be accomplished with a facility on-line, others (such as internal recoating) cannot. It is therefore recommended that the planning and construction of reservoir improvements provide the City operators with the flexibility to maintain these important facilities where feasible.

Storage redundancy is also critical in the wake of natural disasters. As discussed in previous chapters, seismic events present the largest natural disaster threat to these structures.

9.3 WATER STORAGE ANALYSIS

Effective storage volume, system pressures, water quality, and redundancy are some of the factors used to evaluate the suitability of existing water storage reservoirs, and provide recommendations for new reservoirs.

9.3.1 Storage Volume Assumptions

As previously noted, the only the effective storage volume can be counted when evaluating whether a water system meets the water storage goals. The overall storage within a system can be divided into the several categories. The following sub-paragraphs define these storage allocation categories.

9.3.1.1 Operational Storage Assumptions

For the purposes of this report, the operational storage range was assumed to be the upper 2 feet of each of the existing reservoirs. This equates to approximately ±61,000 gallons in the Steel Reservoir (±6% of total reservoir volume), and ±63,000 gallons in the Concrete Reservoir (±17% of total reservoir volume). The net volume of operational storage is 0.124 MG of a total volume of 1.336 MG, which is ±9%. For purposes of planning, it was assumed that operational storage will account for 10% of the volume of any new reservoirs in the future.

9.3.1.2 Equalization Storage Assumptions

If Equalization Storage requires 30% of Maximum Day Demand (mid way between 20% and 40%), the total Equalization Storage required is 0.161 MG (based on MDD of 0.538 MG in 2033).

If the (Peak Hour Demand – Supply) calculation is used along with a time of 3 hours (mid way between 2 hours and 4 hours), the total Equalization Storage required is 0.027 MG. This is using a PHD of 850 in 2033 and a Finished Water Line supply rate of 700 gpm.

Since the MDD approach requires substantially more Equalization Storage, 30% of MDD will be used to calculate Equalization Storage for this study.

9.3.1.3 Standby Storage Assumptions

Standby storage will be calculated at twice (2x) the Average Day Demand. For 2033 this results in a Standby Storage requirement of 0.596 MG (for ADD of 0.296 in 2033).

9.3.1.4 Fire Suppression Storage Assumptions

As discussed in Chapter 5, this report utilizes the design fire flows established by the City's PWDS. The design fire flow condition is a 3,500 gpm event with a duration of 3 hours, which equates to a total fire flow volume (FSS) of 630,000 gallons.

9.3.1.5 Dead Storage Assumptions

For Carlton's system, there is no Dead Storage, thus this criteria is not included in the calculations.

9.3.1.6 Pumped Storage Assumptions

For Carlton's system, there is no Pumped Storage, thus this criteria is not included in the calculations.

9.3.1.7 Effective Storage Assumptions

In the case of Carlton, a significant percentage of the WTP storage reservoir is currently classified as dead storage, as noted above. This dead storage (along with the operational storage) was discounted and not included in the storage volume evaluation and recommendations below. As shown in the tables under Section 9.3.2, construction of a new finish water pump station (with below grade canned vertical turbine pumps) will allow the City to utilize most of the existing dead storage in the WTP reservoir, which makes a tremendous difference on the overall storage requirements.

9.3.2 Storage Volume Evaluation

The total recommended storage in the system is the sum of operational, equalization, fire, and emergency storage (while discounting any dead storage). The first step in evaluating the need for additional storage is to evaluate the volume of existing storage that is available.

Discounting the operational storage and dead storage as noted above, the effective volume of the existing Carlton reservoirs is as listed in **Table 9-2** below.

Table 9–2 Effective Storage Volume, Existing Reservoirs

Existing Reservoir	Total Storage (MG)	Operational Storage [1] (MG)	Effective Storage (MG)	% of Total Storage Available
1 MG Steel Reservoir	0.956	0.061	0.895	94%
0. 38 MG Concrete Reservoir	0.38	0.063	0.317	83%
Totals	1.336	0.124	1.212	91%

[1] Assumes normal operating range of reservoirs consists of the upper 2 foot of each reservoir.

Based upon the criteria discussed above, the storage requirements were evaluated to determine the required storage volumes through the end of the planning period. The results of this analysis are presented in **Table 9–3**. The City currently meets the recommended storage volumes and continues to do so until about 2020. By the end of the study period there is a deficit of about 10% compared to the recommended volume, which is not considered significant considering the conservative nature of the calculations underlying the recommended volumes.

Table 9–3 Finished Water Storage Evaluation (MG)

Year	2012	2015	2020	2025	2030	2033
Equalization (30% MDD)	0.102	0.123	0.130	0.140	0.149	0.155
Emergency (2x ADD)	0.445	0.448	0.472	0.503	0.532	0.551
Fire flow (3 hr @ 3,500 gpm)	0.630	0.630	0.630	0.630	0.630	0.630
Total	1.177	1.201	1.232	1.273	1.311	1.336
Available Effective Storage	1.212	1.212	1.212	1.212	1.212	1.212
Storage Deficit	**-**	**-**	**-0.02**	**-0.061**	**-0.099**	**-0.124**

It should be noted that the above calculations do not take into account any storage at the 0.30 MG Clearwell at the WTP. This is because the primary function of the Clearwell is chlorine contact time for disinfection as discussed in Chapter 7. The CT calculations assume the Clearwell is kept nearly full to maximize CT time. However, as also discussed the current tracer study assume extremely conservative conditions, particularly with regard to temperature. A comprehensive review of CT time vs. storage could result in a portion of the Clearwell being made available for inclusion in the storage calculations.

At this time we do not believe it is necessary to include any Clearwell storage in the overall storage analysis. Furthermore, should there be a desire to include Clearwell storage it is important to keep in mind that the Clearwell provides the source for WTP filter backwash water. Thus, if the Clearwell is drawn down too far complications could arise with attempting to re-start the WTP as backwash water would further diminish the Clearwell volume and reduce chlorine contact time.

9.3.3 Condition of Existing Reservoirs

1MG Steel Reservoir

This reservoir is just over 10 years old and believed to be in good condition. The exterior paint is showing some signs of weathering consistent with its age. The interior was not inspected but is also expected to be in normal condition for a 10 year old reservoir. A detailed coating inspection was outside the scope of work for this study. Based on typical manufacturer’s recommendations, welded steel reservoirs should be recoated at about 15 years maximum intervals.

0.38 MG Concrete Reservoirs

The condition of Concrete Reservoir is not known, but it is believed to be in adequate condition. However, since this reservoir dates to the early 1900s a structural inspection of this reservoir would be appropriate. Such an inspection would be appropriate to verify the existing condition, and identify any work that might be necessary.

The Concrete Reservoir cover consists of a wood frame structure with wood siding and a metal roof. The roof support structure is believed to be in good condition and so is the roof. The wood siding is aging and appears to be ready for major maintenance or replacement in the next few years. A structural inspection of the support structure as inspection of the roof and siding concurrent with the structural inspection of the concrete reservoir would be appropriate...

An additional item to be noted with regard to the Concrete Reservoir is the uncertainty with regard to the exact property boundaries for the parcel on which the concrete reservoir sits. The survey for the Meadow Lake Road Transmission Main project followed the description recorded for the parcel and the resulting property lines do not match the site layout (the reservoir sits close to one edge of the parcel rather than in the center). In addition, there is no record of an easement for the access driveway from Meadow Lake Road to the reservoir site.

9.3.4 System Pressure

The City's distribution system currently operates with pressures in the range of 60 and 80 psi (depending on location and system demand). The distribution system pressure is maintained water level in the finished water storage reservoirs. Since existing system pressures are in the desired range no changes are necessary.

9.3.5 Redundancy

The most common need for storage redundancy arises when a particular storage facility must be removed for inspections or maintenance. Although inspections and minor maintenance can sometimes be performed with the reservoirs in service, in the long run more intensive rehabilitation will require a given facility to be taken out of service. Repainting can often take from 60 to 90 days. For this reason redundant reservoirs in each service level are recommended.

While are typically operated in series, they can be operated independently allowing either reservoir to be taken off line if necessary. However, because the Concrete Reservoir is substantially smaller than the Steel Reservoir, taking the Steel Reservoir off line would result in a major loss of reservoir capacity during the off line period. With the period need to paint the Steel Reservoir, taking it off line at some point will be unavoidable. When that occurs every effort should be made to ensure all other water system components are in optimal condition and that the off line period be kept to the absolute minimum.

9.4 Recommended Storage Approaches & Improvements

The biggest concern with Carlton's finished water storage is the storage deficit that already exists and continues to grow in the future. However, ranging from 12%-25% during the study period these deficits represent a need for planning for additional storage capacity rather than an issue of significant immediate concern. Furthermore, the transmission and distribution system losses downstream of the storage reservoir are significant and represent roughly 25% of the water leaving the Steel Reservoir (±20% of total system demand). Reduction of these losses to 10-15% of the flow leaving the Steel Reservoir would decrease the storage deficits to less than 10% today and less than 20% in 2033.

The following paragraphs outline specific recommended improvements related to the storage system. Recommended budget numbers to cover the capital costs for each of the recommended improvements are presented in Chapter 12.

9.4.1 Water Loss Reduction (Transmission & Distribution Improvements)

As discussed in Section 5.4.4 and Section 6.7.1, the water loss experienced by the Carlton distribution and transmission system is substantial. When prioritizing water system improvements, the City should bear in mind that reduction in distribution system leakage also reduces the City's storage requirements for both equalization storage (30% of MDD) and for standby storage (2 time ADD minus source credits).

As described above, if the City is able to reduce their water loss ratio down to a 10-15% loss relative to the total volume leaving the Steel Reservoir, it will decrease the current storage required in these two categories substantially, with the volume of the decreased storage requirement increasing proportionally throughout the study period.

Recommendations for distribution system improvements that will reduce water loss (and increase the effective volume available from the City's existing sources) are included in Chapter 8.

9.4.2 Recoating the 1 MG Steel Reservoir

As noted above, the City should budget to repaint the 1 MG Steel Reservoir during in the planning period, and if typical painting intervals are used this should occur in the next 5-10 years. The actual timeframe for painting should be based on a detailed inspection of both the exterior and interior of the reservoir by a coating specialist. It is important that painting not be delayed beyond the timeframe recommended by the coating specialist as the coating serves to protect the structural steel, and coating failures (even apparently small ones) can result in costly damage to the steel. It is anticipated that recoating process will require this reservoir to be out of service from 60 to 90 days, during which time the 0.38 MG Concrete Reservoir will need to service the system by itself.

Recommended budget numbers to cover the capital costs for the recommended improvements appear in Chapter 12. The total estimated construction cost includes work to sand blast and paint the inside and the outside of the reservoir. However, the longer this maintenance work is not completed the more it will cost.

9.4.3 0.38 MG Concrete Reservoir Improvements

The anticipated work on the Concrete Reservoir is expected to be limited and relatively straightforward, primarily consisting of maintenance to the wood siding. However, additional work may be necessary depending on the findings of the recommended detailed structural and general inspection of the concrete reservoir, wood roof structure, roof and siding. It is essential that the cover integrity be maintained as this protects the finished water from hazards such as birds, insects, and airborne dirt and dust.

Recommended budget numbers to cover the capital costs for the recommended improvements appear in Chapter 12. The total estimated construction cost includes only replacing the existing wood siding. However, additional costs may be required based on the outcome of the recommended inspection.

In addition to the recommendations regarding the physical structure, we recommend that the City resolve the property boundary issues, including the access driveway.

9.4.4 Summary of Water Storage Recommendations

Table 9-4 is a brief summary of the various water storage recommendations developed by this master plan. For more details on particular projects, refer to the discussions in the body of the study.

Table 9–4: Recommended Water Storage Improvements & Projects

Project Code	Project
R-1	Periodic Internal Coating Inspection of the Steel Reservoir
R-2	Recoating existing 1 MG Steel Reservoir
R-3	Wood Siding Maintenance or Replacement at the 0.38 MG Concrete Reservoir
R-4	Address the questions concerning the Concrete Reservoir Boundary and Access Easement
R-5	Replace steel transmission & distribution mains to decrease volume required for equalization storage and standby storage (see recommended improvements in Chapter 8)

CHAPTER 10

INSTRUMENTATION AND CONTROL EVALUATION

Chapter Outline

INSTRUMENTATION & CONTROL EVALUATION

CHAPTER 10

10.1 INTRODUCTION

Daily, and sometimes hourly, observations of water system operating parameters are required to ensure that the system is performing within regulatory standards and meeting operational goals. Immediate notification of critical alarm conditions is paramount to ensuring a continuous supply of water to the public and is often necessary to protect the City's infrastructure.

In modern public works facilities the various functions of collecting data, controlling equipment, and issuing alarm signals are normally handled by sophisticated electronically controlled equipment and systems. These systems can operate at a couple of different levels:

- Local Control
- Remote Control

Local programmable logic controllers (PLCs) installed at the site of the various water system facilities can control the local system, as well as collect and store operational data. These local PLCs are used to disseminate command information from a central PLC to the process equipment and devices as directed.

Telemetry data transmitted to a central SCADA (Supervisory Control And Data Acquisition) system is available immediately and is thus more useful than data that is stored at a facility. Telemetered alarms provide immediate warning of malfunctions and low water levels, reducing the response time in emergency situations. The electronic collection of operational data in a centralized location improves operator efficiency and the reliability of collected data and enhances the operation of the water system.

The installation of PLC based control systems at each site and a central SCADA system promotes a more efficient operation of the water system by providing the City with information on, and control of, its system while using fewer staff resources.

In addition to supporting day-to-day operations, the SCADA component of the instrumentation and control system call collect, manage, display and export a wide variety of data that can be used for system management and long term planning efforts. To get the greatest benefit out of a SCADA system, careful planning is required on the part of all interested parties, including the operations staff, management staff, engineering staff and the SCADA system designer.

10.2 EXISTING INSTRUMENTATION & CONTROL SYSTEM

A noted in Section 4.7, the City currently has a SCADA system located at the WTP that allows for centralized monitoring and control of the water system by the system operators. The PLC based system includes a graphic based SCADA interface that allows system operators to access the main PLC system through a desktop computer at the WTP, as well as a laptop with remote access capabilities. Measured variables can be viewed, trended and saved on the computer, and operating parameters can be changed. The computer-based interface also provides centralized alarm management with stored alarm logs. In addition, the City has a phone line telemetry system that communicates between the WTP and the 1 MG steel reservoir site.

As originally designed, the SCADA system provided the following functions:

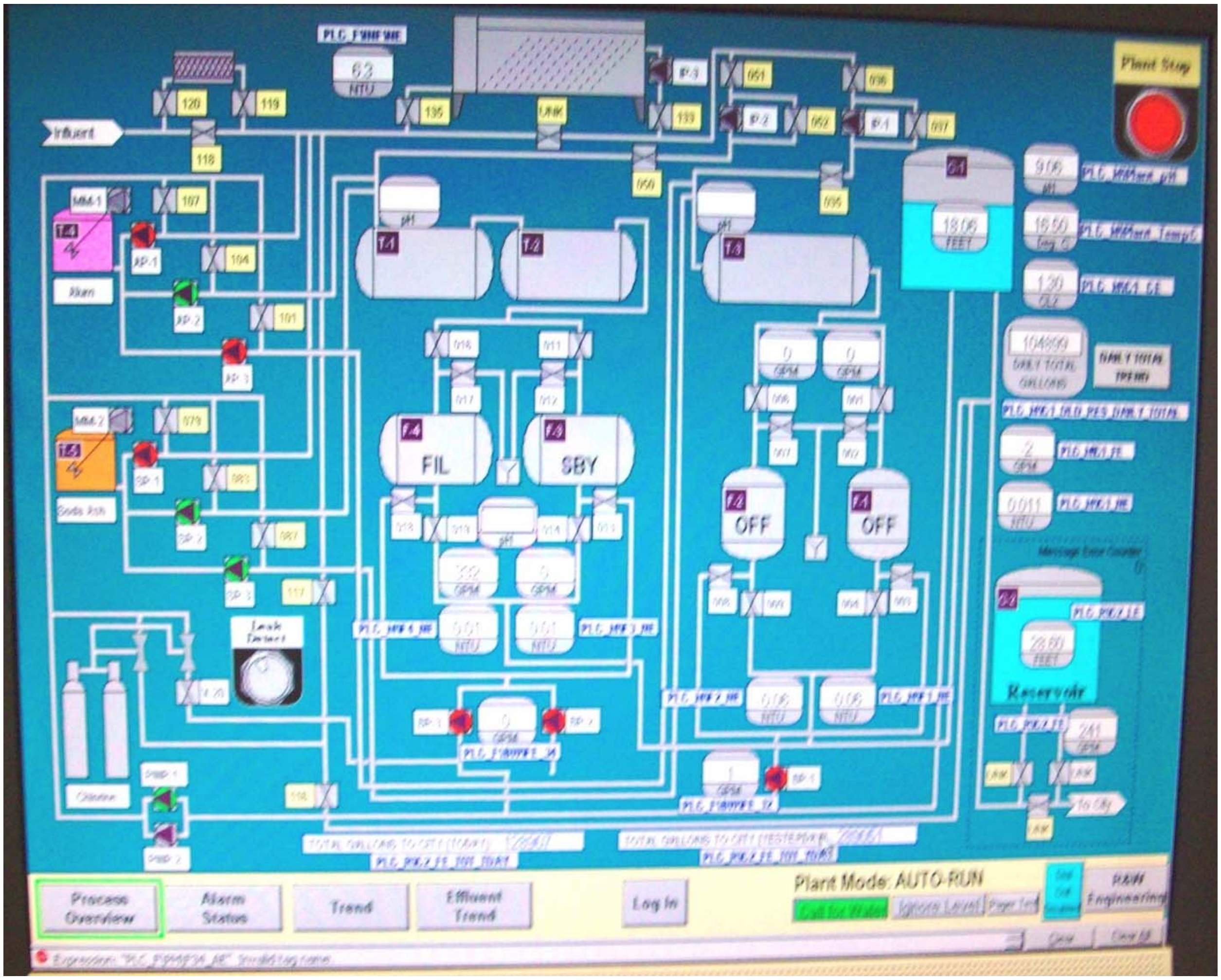
- Display the plant operating status. (Hand, Off, Auto-Run, Auto-Stop)
- Set the plant operating mode. (Hand, Off, Auto)
- Display the influent and effluent turbidity values. (5 values)
- Display the effluent pH value.
- Display the clearwell liquid level value.
- Display the chemical pump status. (Hand, Off, Auto-Run, Auto-Stop)
- Display the filter backwash status for 4 filters. (On, Off)
- Display the backwash flow rate for 4 filters. (4 values)
- Display the flow rate and totalized flow at the Master Effluent flow meter.
- Display the chlorine leak detector alarm status. (Normal, Alarm)
- Display the scrubber chlorine detector status. (Normal, Present)
- Display the chlorine residual value.
- Display the pump operating status for all pumps. (Hand, Off, Auto-Run, Auto-Stop, CB, OL/Fail)
- Display the eye wash alarm status for 3 eye wash stations.(Normal, Alarm)
- Override the door alarm status for all doors. (Normal, Override)
- Override the window alarm status for all windows. (Normal, Override).
- Set the clarifier operating mode. (On, Off)
- Adjust the Clarifier loop SV.
- Adjust the Clarifier minimum run level.
- Adjust the Clarifier minimum start level.
- Adjust the Clarifier Timer 1 preset.
- Adjust the Clarifier Timer 2 preset.
- Set the super-chlorination mode. (On, Off)

Direct, local PLC Control is through a touch screen panel on the face of the main WTP controller door. A copy of the main PLC screen is shown as **Figure 10-2**. The SCADA control is through a touch screen interface on a desktop class personal computer. The main SCADA screen is displayed in **Figure 10-1**. This screen shows the status of all key equipment, the ability to manually control a variety of functions and processes, and displays a wide variety of process data such as flow rates, water levels, and water quality parameters.

The SCADA system has undergone a number of modifications as additional data inputs have been added over the years. Since the system employs desktop computer technology from around 2003, this addition of data input to manage has extended the current system to its limits. Currently when new SCADA functions are desired, older, lower priority ones must be removed because the system is unable to handle the added load. While the system has and continues to serve the City well, a SCADA system upgrade is needed.

Figure 10-1 Water Treatment Plant Main PLC Controller Plant Status Screen

Figure 10-1 Water Treatment Plant SCAD Computer Main Screen



10.3 RECOMMENDED IMPROVEMENTS

While the City's instrumentation and control system is meeting the City's current operational needs, due to the age and capabilities of the underlying desktop computer system, the SCADA system is incapable of tracking, storing, and displaying all of the data that could be useful to the operator and beneficial to long term planning and engineering efforts. Because of this, we recommend that the current SCADA computer system be replaced with a new SCADA system. Rather than an in-kind replacement of the current hardware and interface, it would be beneficial to the City if the replacement process includes a preliminary design phase where all stakeholders (including plant operators, plant managers, and engineers) have the opportunity to provide input on the data to be collected, formats for storage and retrieval, operator interfaces, and other critical design parameters.

CHAPTER 11

OPERATION AND MAINTENANCE

Chapter Outline

OPERATION AND MAINTENANCE

CHAPTER 11

11.1 INTRODUCTION

The maintenance of water systems is necessary to ensure the proper operation of the facilities and to obtain the full useful life of those facilities. Water systems represent a significant investment of public capital. If a water system is allowed to fall into disrepair because of the lack of maintenance, it will not operate efficiently or as designed. Health problems and property damage may result from leaking mains or services, mainline breaks, inoperable valves or fire hydrants. The repair of failed portions of a public water system is costly, quite often equaling or exceeding the original cost of construction. Because of this, it is imperative that municipalities consistently provide adequate maintenance funding and staffing to protect their investment.

System maintenance is frequently classified as preventative or corrective. Preventative maintenance involves routinely scheduled inspections of the system and the collection of data to identify problem areas. The proper documentation and analysis of collected data should be performed so that scheduled maintenance can be allocated to specific problems. As a general rule, as preventative maintenance increases, the amount of corrective maintenance required decreases.

Corrective maintenance, often referred to as emergency maintenance, is typically performed when the water system fails, such as leaking mainlines, inoperable pumps, control systems or fire hydrants. Corrective maintenance requires immediate action and the City will typically pay a premium for the completion of this work.

Therefore it is important to emphasize that preventative maintenance, documentation, and program evaluation ultimately results in a lower cost to the consumer by extending the life of the treatment, distribution or storage system components and reducing costs associated with unscheduled or emergency repairs.

11.2 WATER SYSTEM RECORD KEEPING

Record keeping is an important part of a successful operation and maintenance program.

Unfortunately, record keeping is often neglected because of time and staffing limitations, and the often immediate needs of other maintenance programs. The following categories of record keeping are viewed as central to improving the long term efficiency of the operation and maintenance program.

11.2.1 Water Production

The planning elements of water system expansion and water conservation are strongly rooted in the evaluation of water system demands. The recording of daily water production and billing records provides a basis for projecting future system needs and measuring the efficacy of conservation efforts. The City should continue its good practice of diligently recording water use.

Water use data collection should include:

- Daily water production. The City currently records flow through the water treatment plant filters, which represents the water diverted from Panther Creek/Carlton Reservoir (except for flow used to monitor influent water characteristics such as pH and turbidity, and the flow used for backwashing the filters). The City does not currently record the flow through the master effluent meter downstream of the clearwell. Keeping a daily record of the master effluent meter provides the best measure of water entering the City's distribution system, allowing tracking of distribution system leakage and also allows an accurate picture of the amount of water being used in the treatment process.
- Historical water use. Track average day, maximum day and monthly total diverted water and demands. Specifically tracking diverted water allows a ready comparison with water usage with respect to water rights. The demand data is needed for comparison with system consumption and helpful in monitoring system losses.
- Meter readings at the Steel Reservoir. This is currently done and should continue. In conjunction with WTP master effluent meter and WTP-Storage Reservoir consumption data would allow tracking of losses by area, whether upstream or downstream of the storage reservoirs.
- Unaccounted-for-water, recorded on a monthly and annual basis to include a breakdown of non-revenue water.
- Waste streams from source and treatment facilities.
- Streamflow data for Panther Creek, particularly during summer months when flow is the lowest.

11.2.2 Regulatory Record Keeping

It is the responsibility of the water system operations staff to develop and maintain records relating to the quality of the water produced as well as the condition of the physical components of the system. These requirements are detailed in OAR 333-061-0040. Regulatory records should be maintained at a convenient location within or near the area served by the water system. **Table 11-1** provides an overview of record keeping requirements. Depending on the final treatment methods provided, and the future determination of whether the City's springs are under the direct influence of surface water, additional record keeping may be required. Operators are encouraged to review the statute for the most current compliance requirements as other rule specific requirements may apply.

Table 11-1 General Regulatory Record Keeping Requirements

Specific Record or Report	Record Retention
Residual disinfectant measurements	2 years
Copies of public notices issued pursuant to OAR 333-061-0042 and certifications made to ODWS	3 years
Actions taken to correct violations of primary drinking water regulations	3 years (1)
Bacteriological analysis	5 years
Monitoring plans for disinfection byproducts	5 years
Consumer Confidence Reports	5 years
Records concerning variances or permits	5 years (2)
Chemical analysis, secondary contaminants, turbidity and radioactive substances results	10 years
Reports, summaries or communications on sanitary surveys	10 years
Lead and Copper Rule data	12 years

(1) Retention period begins after the last action taken with respect to the particular violation
(2) Retention period begins after the expiration of the variance or permit

The City is also encouraged to retain organized records of all correspondence with regulators, operator certificates, and the results of any comprehensive performance evaluations.

11.2.3 Operations and Maintenance Records

There are commercially available software programs that allow cities to develop a comprehensive maintenance system to manage operational efforts for the water and wastewater systems (such as those developed by the Hansen Software Corporation). This computer software tracks and schedules work orders, labor expenditures, regularly scheduled maintenance activities, inspection reports, and repairs.

If the City does not currently use software of this type, it is recommended that the City consider acquiring software to maintain a detailed accounting of time spent on various operations and maintenance tasks. This information is helpful to establish the need for additional staff, equipment, training or other resources that may be required to accomplish operations and maintenance programs.

The software should also be utilized to maintain a detailed inventory of facility specific maintenance records as this information will be required during future planning efforts to estimate the value and condition of City infrastructure.

11.2.4 Water System Mapping & System Inventory

The City coordinates through the City Engineer to use AutoCAD to inventory and map their installed infrastructure. A complete inventory of the water system will greatly improve operational efficiency and will enhance future planning efforts.

As is often the case with municipal systems of its size, the City relies on the memory and experience of staff members to provide a full account of many system details. As the City continues to grow, it becomes increasingly important that this wealth of information is transferred and organized into a formalized record keeping system. The integration of historical knowledge and mental records into a GIS system is considered to be of high value.

This report recommends, as technology advances during the study period, that the City consider developing a GIS inventory for the water system components to include pipes, valves, hydrants, pumps, reservoirs, water meters, and other facilities. Key elements of existing water system record drawings can be integrated into this database to provide operators with a single point resource for water system information.

11.3 Water Use Audit

The definition of unaccounted-for-water is defined as water which is lost through leaks, evaporation, or use that is not recorded and/or accounted-for. Unaccounted-for-water includes distribution pipe leakage, unmetered water use such as fire fighting, hydrant flushing, overflows, street cleaning, WTP backwash water or instrumentation error.

The City has not performed periodic water audits on a regular basis. It is recommended that the City begin performing annual water audits as set forth in OAR 690-086-150(4a). The City should begin with an inventory of all unmetered uses and install metering devices at these locations to the greatest extent possible. In the event metering is not feasible, estimates should be made to record the unmetered use.

An annual water audit should utilize sum of all metered sales from each customer class and production records and should be performed in a systematic and well-documented manner to accurately quantify all authorized unmetered and unauthorized uses.

11.4 Leak Detection

The City has retained consultants to perform a couple of leak detection studies over the past few years, the most recent occurring in March 2013. The studies utilized sonic detection equipment to locate and quantify distribution system leaks around town, which resulted in the City being able to find and repair a number of leaks.

Although no formal program currently exists, the City is making incremental progress to develop a leak detection and repair program. We recommend that the City establish a goal for an annual budgetary line item of $5,000 to accomplish this.

As discussed above regarding data collection for water production, it would be a relatively straightforward process to set up a system that allowed monthly checks on the overall system leakage with separate totals for upstream and downstream of the finished water storage reservoirs. Based on the analysis performed for Chapter 5, the 2013 leak detection study seemed to provide a good estimate for leaks downstream of the steel reservoir, but may have missed a substantial amount of leakage upstream of the storage reservoirs. Especially for the harder to notice and harder to find leaks between the WTP and the storage reservoirs, having usable monthly data would help the City identify leaks in this section of waterline.

As leaks are detected and repaired throughout the system, this information should be entered into the City's O&M records. The City may wish to develop a map that will allow them to graphically document and track their progress and findings. The mapping should include areas that have been monitored and tested for leaks, the location of all galvanized or deteriorating pipe, and the locations of all distribution system repairs.

11.5 Distribution System Flushing Program

Maintaining water quality and preserving the hydraulic capacity of a water distribution system is a key concern for water utilities. Mineral precipitation, microbiological activity, and corrosion can all form deposits on the pipe walls and contribute to a reduction in flow and water quality.

Flushing the distribution water mains is an effective way to maintain water quality and system capacity.

A properly conducted flushing program can improve water quality by restoring the disinfectant residual, reducing bacterial re-growth, dislodging biofilms, removing sediments and deposits, controlling corrosion, restoring flows and pressures, eliminating taste and odor problems, and reducing disinfectant demand throughout the system. These benefits prolong the life expectancy of the distribution system and reduce the potential for waterborne disease outbreaks.

The Public Works Department does not currently have a formal program to purge distribution lines with a goal of flushing the entire distribution system on a regular basis.

As the City develops a flushing program in the future, they should optimize the flushing program by developing a comprehensive unidirectional flushing (UDF) program. The current layout of the distribution system should allow the City to utilize UDF to flush each section of the City sequentially, working from the North Yamhill River toward the northern, eastern and southern extents of the distribution system in a sequential manner.

The central premise behind a UDF is to focus flushing energy into a single distribution line isolated from the general grid using selected valve closures. This has the advantage of achieving higher scouring velocities (on the order of 5-6 fps) and has been estimated to require 40 percent less water than a conventional flushing approach. Additionally, the sequential system-wide use of UDF permits the controlled movement of sediments from cleaned areas near the source to the periphery of the system.

The City should develop a flushing program and consider future opportunities to add valves as required to economize the process.

11.6 Valve Exercising

Many components of the water system require periodic maintenance to remain functional. Valves and hydrants, in particular, must be exercised on a regular basis to ensure that they remain in operational condition. It is commonly recommended that all valves be exercised annually; however, this is often times not practical due to staffing limitations. We are not aware of the City conducting valve exercising other than that which is performed as part of system flushing or repairs.

A complete valve exercising program should include the following elements:

- Systematically locating and accessing all distribution system valves. Often valves boxes have been paved over or are partially buried and are difficult to locate. Valve boxes should be cleaned out to fully expose the valve nut, adjusted and realigned as necessary to allow unobstructed access to the valve. Structurally damaged valve boxes should be replaced.

- Each valve should be operated a minimum of two full cycles and an additional cycle if the torque on the valve is high.
- Replacement of the gland packing. In many cases minor leaks in the packing will stop once the gland packing is wetted and is exercised; however, the valve should be repaired if the packing is damaged and the leak does not stop.
- All data collected from the event (valve location, size, initial open/closed status, number of turns, torque (if measured), and any other anomalies should be entered into the City's maintenance database.
- Perform minor street repairs around the valve box as required.

Valve exercising should be coordinated with flushing operations to ensure that any debris in the distribution system dislodged by the valve exercising is flushed from the system.

In cases where staffing levels do not permit the execution of a full exercising program staff should focus on operating each valve greater than 12-inches on an annual basis and other system valves on a 4 year cycle.

11.7 Cross-Connection Control Program

Oregon Administrative Rules 333-061-0070 through 0074 detail the requirements for a cross-connection control program. The City is required to establish a cross-connection ordinance and must submit an annual report to ODWS. Systems with more than 300 service connections are required to provide a certified tester.

The City's currently has a cross-connection control program. The City currently employs one certified cross connection control specialist and is responsible for inspecting new devices and installations, monitoring annual inspections, terminating water service in cases of non-compliance, and compiling submitting the annual inspection report to ODWS.

We recommend that the City continue funding this program and work to integrate the location of all backflow devices into the water system mapping. The identification and monitoring of high risk installations is also recommended, and as outlined in OAR 333-061-0070, it may be appropriate to test high risk installations more frequently than once per year.

11.8 Master Meter Maintenance

Master meters are installed downstream of the Clearwell and also downstream of the 1 MG steel reservoir. The Clearwell meter records the total water entering the distribution grid, while the 1 MG steel reservoir meter records the total demand for all locations downstream of that meter (including Meadow Lake Road toward town, the City Limits/UGB, Valley View Water Company and East Carlton Water Company). Data from these meters is utilized in conjunction with consumed water from metered connections to establish benchmarks for water loss.

Discussions with staff indicate that some of these meters have not been calibrated for some time, and there is no program designated to accomplish this. It is recommended that these meters be calibrated on an annual basis to ensure that water loss and other operational decisions are being made on a sound basis.

11.9 Water Meter Maintenance

The accuracy and performance of water meters is vital to utilities whose billable revenues are derived directly from the collected readings. Loss of revenue from inaccurate or broken meters can be significant and may warrant a meter testing schedule. Meters tend to under-register over time because of wear and deposits, and since almost all meters loose accuracy with age, any utility can sooner or later find economic justification for meter maintenance.

11.9.1 Large & Mid-Size Meters

An important part of a water utility's operations should be a systematic testing and maintenance program for its larger meters. Large meter installations typically represent a significant portion of a utility's revenue and the cost of a program that focuses on proper installation, maintenance and calibration of these larger meters is often a small compared to the potential gain in revenue. The definition of large meters is typically defined as those that are 3-inches or larger.

It is recommended that meters 3-inches and larger be tested and calibrated annually, and that all 2-inch meters be tested and calibrated on a 5-year interval. Large meter installations should be inspected to confirm whether strainers, isolation valves and test ports are present. The length of exposed straight pipe in the meter set should be observed for conformance to the manufacturer's recommendation. Flow-demand recording devices can be utilized to confirm that larger meters are appropriately typed and not oversized for the service they see, since significantly oversized meters can result in lost revenue because of inaccurate registration during periods of low flow. Using the correct size and type of meter for each application, combined with routine calibrations, will ensure that customers are charged equitably for water use.

11.9.2 Conventional Meters

The City currently utilizes a touch-read meter reading system. Many manufacturers recommend a ±10-year life cycle for new meters. We recommend that the City verify this meter cycle replacement with the meter manufacturer, and plan to begin an incremental meter replacement program as applicable.

The City should develop a meter replacement schedule and should begin recording meter location, make, type, size, and age in the maintenance database along with service dates, next scheduled inspection and repair notes. This should be performed on a routine interval to ensure that meter age and maintenance history is readily known.

11.10 Hydrant Maintenance And Replacement

Hydrants are maintained and replaced on an as-needed basis as they are damaged, or as problems are identified in the flushing and hydrant testing programs. Due to budgetary constraints, there is currently no formal hydrant infill program other than the policy of replacing or augmenting hydrants as waterlines are constructed and/or replaced.

The City's PWDS require that all new hydrants be connected to the distribution main with a minimum 6-inch diameter hydrant lead. It is recommended that as hydrants are replaced, that the hydrant leads are also evaluated to ensure compliance with this standard.

Ultimately it is the community, through its economic decisions with respect to taxation and user fees, that determines the standard of fire protection and coverage. To the degree that funding is available, the City is encouraged to develop an inventory of existing hydrant coverage and to integrate this in the maintenance program so that future infill efforts can proceed in a logical fashion.

11.11 Reservoir Inspection And Maintenance

Reservoirs should be inspected and potentially cleaned every 2 to 5 years. This process typically requires the use of divers. Once every ten years each reservoir should be drained for a thorough inspection and cleaning. Structural improvements or recoating can be conducted during these periods.

The City should work on establishing an annual reservoir maintenance program (on a rotating basis), with a proposed an annual inspection budget of $5,000. The existing reservoirs should be taken off-line for a thorough evaluation and cleaning as soon as feasible.

11.12 Emergency Generator Maintenance

In order to provide for the reliable production and distribution of water for public use and for fire fighting, it is recommended that the City perform routine maintenance on their emergency generators. Routine maintenance of the City's back-up generators should be contracted out by the City and performed by manufacturer certified technicians.

11.13 Emergency Response Plan

OAR 333-061-0064 requires all public water systems to maintain a current emergency response plan. The purpose of an emergency response plan (ERP) is to provide a guideline for water system operators and emergency personnel to minimize disruption of normal services to its consumers and to provide public health protection and safety from disruptions caused by a seismic event, fire, facility failure, or other incident. The City should ensure that its ERP remains current and up to date, in accordance with the regulatory requirements promulgated in the wake of Sept. 11, 2001.

The ERP should identify a command and control structure within the Public Works Department and define procedures for coordinating emergency responses with the municipal fire and police departments, as well as state and federal agencies as required. Training exercises and drills are performed on a regular basis for all Pubic Works personnel who are required to respond to emergencies. These exercises are also conducted whenever staffing assignment changes are made.

The City should follow a practice of training, and work to update the ERP as the significant infrastructure improvements of this report are implemented. In addition, OAR 333-061-0064 requires that the City's ERP be reviewed and updated every 5 years and that the list of emergency contacts be updated annually.

11.14 Staffing Levels

The Public Works Department currently employs 3 full time employees, with seasonal help hired as required. Due to the size of the department, none of the current staff are dedicated solely to the water system. The recommendations contained in this report do not provide any significant additional workload requirements on the Public Works Department or other City Staff.

11.15 ANNUAL OPERATIONS & MAINTENANCE BUDGET

Annual Operation and Maintenance (O&M) costs are recurring costs typically funded through user rates. **Table 11–2** presents City's annual adopted O&M costs for water utility and water treatment for the 2013-2014 fiscal year.

Table 11–2 Annual Operation and Maintenance Budget

Item	2013-2014 Adopted Budget
Personal Services	$252,672
Materials & Services	$195,300
Capital Improvements	$55,600
Subtotal	$503,572
Transfers	$469,540
Debt Service	$0
Contingencies	$232,888
Total	$1,206,000

It should be noted that the improvements recommended by this plan are not expected to require additional Public Works staff or other increases in operations and maintenance costs. The distribution system improvements constitute a large portion of the proposed improvements and these are likely to have only a minor impact on the operation of the system.

CHAPTER 12

CAPITAL IMPROVEMENT PLAN

Chapter Outline

RECOMMENDED CAPITAL IMPROVEMENT PLAN

12.1 Introduction

As documented in the previous sections, there is a need for water system improvements within the study area to correct existing and projected deficiencies. Some of these deficiencies are more critical than others. While some deficiencies prevent the City from providing the desired level of service, other deficiencies will manifest as the City expands and as the existing systems continue to age.

Recommended improvements for specific components of the City's water system have been described in previous chapters. This chapter builds on that work by assigning a priority and cost to each of the improvement recommendations. The cost estimates have been developed to a conceptual level, for general planning and budgeting purposes (see Section 12.3). More detailed cost estimates will be necessary as the projects are implemented.

12.2 Prioritized Improvements

Since the scope of the proposed improvements is quite large, a prioritizing process is required. Projects that resolve immediate deficiencies or public health concerns should naturally have a higher priority than long term growth related improvements. The following approach is designed to provide a basis for evaluating and ranking the improvement projects.

12.2.1 Prioritization Criteria

The assignment of a particular project or capital improvement project to a priority level was made after an evaluation using the following criteria:

- *Public Health Concerns*. Projects targeted to resolve existing or near term regulatory compliance issues were assigned the highest priority.
- *Consumed Infrastructure (end of useful life)*. Projects to replace damaged or deteriorated infrastructure (particularly those facilities that have reached the end of their useful life and no longer function as designed) were assigned a higher priority.
- *Capacity or Size Deficiencies*. The severity of the deficiency was considered and compared with the service improvements provided by the replacement components. The projected benefit (versus cost) of a project was used to assign a priority.
- *City Priority*. Projects identified by City operations and maintenance personnel to be high priority due to operational or maintenance problems.
- *Development Demand*. The anticipated timeframe for the development of land within the service area of proposed improvements was considered. Projects to serve approved or near term developments should be given higher priority than improvements targeted to long term future developments.

12.2.2 Prioritization Levels

In order to assist the City with their planning, scheduling and construction efforts, each improvement project was assigned to one of three priority levels. The priority levels are:

12.2.2.1 Priority 1—Near Term Improvements

These projects are targeted to problem areas needing immediate attention. They are projects necessary to resolve existing or near term system deficiencies, resolve regulatory compliance issues or to serve known near term demand increases. It is recommended that Priority 1 improvements are undertaken as soon as practical (as quickly as financing can feasibly be arranged and construction/permitting/land or easement acquisition considerations can be addressed).

Since it is unlikely that the City can arrange financing for all of the necessary improvements at one time, the Priority 1 group has been further subdivided into 1A and 1B projects, with 1A being the more critical. It is anticipated that specific group 1B projects will be executed alongside the work of 1A on an as-needed basis.

12.2.2.2 Priority 2—Intermediate Improvements

These are projects that will be needed to provide adequate water service based on anticipated future growth and development. Although not critical at this time, they should be considered as improvement projects that will be upgraded to Priority 1 prior to the end of the planning period.

12.2.2.3 Priority 3—Long Term Improvements/Possible Future Need

These projects are needed to improve system reliability or to supply future demands if land develops to the zoned densities. While important, they are not considered to be critical at the present time. If possible, improvements in this category should be incorporated into on-going citywide development and improvement projects to capture the savings associated with concurrent construction. Some (but not all) projects to be constructed by developers with future developments were also assigned to this group.

12.2.3 Prioritized Capital Improvement Projects & Estimated Project Costs

To aid in the development of a water system capital improvement program (CIP), each improvement project was examined and assigned to one of the priority classes described above.

Table 12-1 below summarizes the priority category totals presented in **Table 12-2**.

Table 12-1 Cost Summary, Capital Improvement Recommendations

Priority Group	Total Estimated Project Cost
Priority 1A	$ 4,092,000
Priority 1B	$ 8,854,000
Priority 2	$ 4,512,000
Priority 3	$933,000
TOTAL	$18,391,000

Table 12-2 is a comprehensive listing of the recommended water system improvement projects. The general location of many of the prioritized improvements is shown on **Figures 12-1** through **Figure 12-5** (following the table). It should be noted that the project listing within a priority class is also ranked in general order of recommended priority (although Public Works and the City Council will set the final project prioritization). The cost estimates are rounded to the nearest $1,000 increment. The reader is referred to previous chapters of this report for more detailed descriptions of the individual projects.

At a minimum, it is recommended that all of the Priority 1A, 1B, and Priority 2 improvements be included in the CIP. The Priority 3 improvements are largely growth driven. In general, it is envisioned that the Priority 3 improvements will be constructed as part of future development and that the developer will pay for the improvements (i.e. without SDC credits).

SDC credits would be available for Priority 1 or 2 projects constructed by developers (assuming they are on the CIP upon which the SDC is based). If the City Council decides that they wish to promote development in certain areas, selected Priority 3 improvements can be included in the CIP (or added in the future).

To the extent feasible, it is recommended that the City implement as many of the Priority 1A improvements under a single funding package if possible, and under as few funding packages as possible otherwise. Work on the Priority 1A and 1B improvements should begin as soon as feasible after agency approval and City adoption of this master plan. It is anticipated that Priority 2 projects will be required within the planning period; however, these projects can begin as finances become available and as the need arises.

CITY OF CARLTON WATER MASTER PLAN

TABLE 12-2 CIP PRIORITIZATION MATRIX

Project	Project Description	Estimated Project Cost	Capital Cost	Consequence of Failure	Probability of Failure	Regulatory Compliance	Improves Fire Flow	Improves Water Quality	Improves Operability	Economic Development	TOTAL POINTS	Priority Group
		Weighing Factor (1-3)	1	3	3	2	2	1	1	1		
Priority 1A Improvements			**Matrix Scoring**: Based on a scale of 1 to 4 with 1 being the 'least favorable' and 4 the 'most favorable'									
F-1	Finished Water Supply Line Contingency Reserve (WTP to Concrete Reservoir)	$ 50,000 [1]	3	4	4	1	1	1	1	1	**34**	1A
S-1	Panther Creek Reservoir Contingency Reserve	$ 50,000 [2]	3	4	2	2	1	3	3	1	**34**	1A
S-3	WTP Intertie with McMinville Water & Light	$ 150,000	3	4	2	1	1	1	3	1	**30**	1A
T-1	Concrete Reservoir – Valve Improvements	$ 35,000 [3]	4	3	2	3	1	1	4	1	**33**	1A
T-2	Meadow Lake Transmission Main, Segments B–E (From Steel Reservoir to Yamhill Street)	$ 2,017,000	1	4	2	1	3	1	1	3	**32**	1A
D-1	North Kutch Street (Monroe to Madison)	$ 55,000	1	2	1	1	4	2	1	3	**26**	1A
D-2	West Monroe Street (Yamhill to Kutch)	$ 42,000	1	2	1	1	4	2	1	4	**27**	1A
D-3	West Monroe Street (Kutch to Pine)	$ 60,000	1	2	1	1	4	2	1	4	**27**	1A
D-4	North Yamhill Street (Main to Monroe)	$ 92,000	1	2	1	1	4	2	1	4	**27**	1A
D-5	North Pine Street (Main to Monroe)	$ 90,000	1	2	1	1	4	2	1	4	**27**	1A
D-6	West Main Street (Yamhill to Kutch)	$ 87,000	1	2	1	1	4	2	1	4	**27**	1A
D-7	South Yamhill Street (Main to Grant)	$ 57,000	2	2	1	1	4	2	1	3	**27**	1A
D-8	West Grant Street (Yamhill to Pine)	$ 134,000	1	2	1	1	4	2	1	3	**26**	1A
D-9	South 3rd Street (Main to Polk)	$ 271,000	1	2	1	1	4	2	2	2	**26**	1A
D-10	Railroad ROW (Johnson to Roosevelt)	$ 228,000	1	2	1	1	3	2	1	3	**24**	1A
D-11	West Johnson Street (Kutch to Railroad ROW)	$ 63,000	2	2	1	1	3	2	1	2	**24**	1A
D-12	North Kutch Street (Madison to Johnson)	$ 173,000	1	2	1	1	3	2	1	2	**23**	1A
D-13	East Monroe Street (1st to 4th)	$ 167,000	1	2	1	1	3	2	1	2	**23**	1A
D-14	North 3rd Street (Main to Monroe)	$ 86,000	1	2	1	1	3	2	1	2	**23**	1A
D-15	West Monroe Street (Pine to 1st)	$ 100,000	1	2	1	1	3	2	1	2	**23**	1A
V-1	New 4-inch Isolation Valves (Various Locations)	$ 44,000	4	1	1	1	1	2	4	1	**21**	1A
V-2	New 6-inch Isolation Valves (Various Locations)	$ 67,000	4	1	1	1	1	2	4	1	**21**	1A
V-3	New 8-inch Isolation Valves (Various Locations)	$ 14,000	4	1	1	1	1	2	4	1	**21**	1A
M-1	East Carlton Water Company Water Meter and Double Check Valve	$ 60,000	2	1	1	2	2	1	3	1	**21**	1A

Priority 1A Estimated Cost Total
$ 4,092,000

Project Code Legend:

D = Distribution F = Finished Water Line R = Reservoir/Storage S = Water Source/Supply T = Transmission V = Valve Replacement WT = Water Treatment

Footnotes:

1. Project F-1 is an **annual** contingency reserve budget for anticipated near-term repair projects related to the finished water supply line. The total cost of waterline replacement appears as project F-2 under the Priority 1B Improvements.
2. Project S-1 is a contingency reserve budget for a near-term feasibilty study or pilot dredging project. Total cost of the reservoir dredging and rehabilitation appears under the Priority 2 Improvements.
3. Project T-1. The final scope of this project is still being evaluated.

CITY OF CARLTON WATER MASTER PLAN

TABLE 12-2 CIP PRIORITIZATION MATRIX

Project	Project Description	Estimated Project Cost	Capital Cost	Consequence of Failure	Probability of Failure	Regulatory Compliance	Improves Fire Flow	Improves Water Quality	Improves Operability	Economic Development	TOTAL POINTS	Priority Group
		Weighing Factor (1-3)	1	3	3	2	2	1	1	1		
Priority 1B Improvements			**Matrix Scoring**: Based on a scale of 1 to 4 with 1 being the 'least favorable' and 4 the 'most favorable'									
R-1	Internal Coating Inspection of Steel Reservoir	$ 15,000 [1]	4	2	1	1	1	1	1	1	**20**	1B
R-2	Concrete Reservoir Siding, Roofing and Electrical	$ 150,000	2	2	1	2	1	1	1	1	**20**	1B
WT-1	Internal Coating Inspection of Clearwell	$ 15,000 [2]	4	2	1	1	1	1	1	1	**20**	1B
T-3	Meadow Lake Transmission Main, Segment A (From Concrete Reservoir to the Steel Reservoir)	$ 368,000	1	4	4	1	1	1	1	1	**32**	1B
F-2	WTP Finished Waterline (WTP to Concrete Reservoir)	$ 6,765,000 [3]	1	4	4	1	1	1	1	1	**32**	1B
D-16	North Yamhill Street (Roosevelt to McKinley)	$ 47,000	3	1	1	1	3	1	1	1	**20**	1B
D-17	West McKinley Street (Yamhill to Scott)	$ 110,000	2	1	1	1	3	1	1	1	**19**	1B
D-18	West Johnson Street (Kutch to Howe)	$ 149,000	2	1	1	1	3	1	1	1	**19**	1B
D-19	West Jefferson Street (Yamhill to Kutch)	$ 51,000	2	1	1	1	3	1	1	1	**19**	1B
D-20	West Madison Street (Yamhill to Kutch)	$ 53,000	2	1	1	1	3	1	1	1	**19**	1B
D-21	South Cunningham Street (Main to Grant)	$ 37,000	2	1	1	1	3	1	1	1	**19**	1B
D-22	West Grant Street (Cunningham to River)	$ 73,000	2	1	1	1	3	1	1	1	**19**	1B
D-23	South Carr Street (Main to Grant)	$ 47,000	2	1	1	1	3	1	1	1	**19**	1B
D-24	South Scott Street (Main to Grant)	$ 60,000	2	1	1	1	3	1	1	1	**19**	1B
D-25	South Park Street (Grant to Polk)	$ 188,000	1	1	1	1	3	1	1	1	**18**	1B
D-26	Polk Street (Park to SE of the Elementary School)	$ 289,000	1	1	1	1	3	1	1	1	**18**	1B
D-27	East Harrison Street (2nd to Linke)	$ 158,000	1	1	1	1	3	1	1	1	**18**	1B
D-28	South Linke Avenue & Elementary School Loop (Harrison to Polk)	$ 134,000	1	1	1	1	3	1	1	1	**18**	1B
D-29	South Park Street (Polk to Adams)	$ 137,000	1	1	1	1	3	1	1	1	**18**	1B
D-30	West Adams Street (Park to Pine)	$ 38,000	3	1	1	1	2	1	1	1	**18**	1B

Priority 1B Estimated Cost Total

$ 8,854,000

Project Code Legend:

D = Distribution F = Finished Water Line R = Reservoir/Storage S = Water Source/Supply T = Transmission V = Valve Replacement WT = Water Treatment

Footnotes:

1. Project R-1. Periodic inspections are required to document the integrity of the internal coating system. The findings of this inspection may defer or accelerate the recoating project for this facility.
2. Project WT-2. Periodic inspections are required to document the integrity of the internal coating system. The findings of this inspection may defer or accelerate the recoating project for this facility.
3. Project F-2. The large capital cost of this project puts it in a unique caterogy apart from other CIP projects. This is a very important project but funding the full project has the tendency to exclude progress on all other projects. The recommended approach to fund and complete this large project is to setup an annual reserve fund (Project F-1) for interim repairs until the full project (F-2) can be funded.

CITY OF CARLTON WATER MASTER PLAN

TABLE 12-2 CIP PRIORITIZATION MATRIX

Project	Project Description	Estimated Project Cost	Capital Cost	Consequence of Failure	Probability of Failure	Regulatory Compliance	Improves Fire Flow	Improves Water Quality	Improves Operability	Economic Development	TOTAL POINTS	Priority Group
		Weighing Factor (1-3)	1	3	3	2	2	1	1	1		
Priority 2 Improvements			**Matrix Scoring**: Based on a scale of 1 to 4 with 1 being the 'least favorable' and 4 the 'most favorable'									
S-2	Panther Creek Reservoir Dredging & Rehabilitation	$ 2,750,000 [1]	1	1	1	2	1	2	2	1	**18**	2
D-31	West Grant Street (Carr to Yamhill)	$ 157,000	1	1	1	1	3	1	1	1	**18**	2
D-32	North Yamhill Street (Johnson to McKinley)	$ 152,000	1	1	1	1	2	1	1	1	**16**	2
D-33	North Howe Street (Johnson to Lincoln)	$ 70,000	2	1	1	1	2	1	1	1	**17**	2
D-34	North Gilwood Street (Monroe to 4-inch Loop Line)	$ 76,000	2	1	1	1	2	1	1	1	**17**	2
D-35	East Jefferson Street (1st to 4th)	$ 126,000	2	1	1	1	2	1	1	1	**17**	2
D-36	North 3rd Street (Monroe to Jefferson)	$ 95,000	2	1	1	1	2	1	1	1	**17**	2
D-37	West Monroe Street (Scott to Yamhill)	$ 119,000	2	1	1	1	2	1	1	1	**17**	2
D-38	East Monroe Street (4th to 6th)	$ 81,000	2	1	1	1	2	1	1	1	**17**	2
D-39	North 1st Street (Main to Monroe)	$ 70,000	2	1	1	1	2	1	1	1	**17**	2
D-40	North 2nd Street (Main to Monroe)	$ 70,000	2	1	1	1	2	1	1	1	**17**	2
D-41	North 5th Street (Main to Monroe)	$ 70,000	2	1	1	1	2	1	1	1	**17**	2
D-42	Main Street Connections (5th & 6th Street Intersections)	$ 27,000	2	1	1	1	2	1	1	1	**17**	2
D-43	South Kutch Street (Grant to Taft)	$ 124,000	2	1	1	1	2	1	1	1	**17**	2
D-44	West Taft Street (Kutch to Park)	$ 37,000	2	1	1	1	2	1	1	1	**17**	2
D-45	East Taft Street (2nd to 3rd)	$ 38,000	2	1	1	1	2	1	1	1	**17**	2
R-2	Recoating existing 1 MG Steel Reservoir	$ 261,000 [2]	1	1	1	1	2	1	1	1	**16**	2
WT-2	Recoating Existing 0.38 MG Clearwell	$ 189,000 [3]	1	1	1	1	2	1	1	1	**16**	2

Priority 2 Estimated Cost Total
$ 4,512,000

Project Code Legend:

D = Distribution F = Finished Water Line R = Reservoir/Storage S = Water Source/Supply T = Transmission V = Valve Replacement WT = Water Treatment

Footnotes:

1. Project S-2. The urgency and scope of the Panther Creek Reservoir Dredging project is contingent on the findings of the feasibility study associated with project S-1 as well as the annual rate of siltation and the associated decline in water quality.
2. Project R-2. The urgency of the steel reservoir recoating project is contingent on the findings of periodic internal coating inspections as itemized in Project R-1.
3. Project WT-3. The urgency of the clearwell recoating project is contingent on the findings of periodic internal coating inspections as itemized in Project WT-2.

CITY OF CARLTON WATER MASTER PLAN

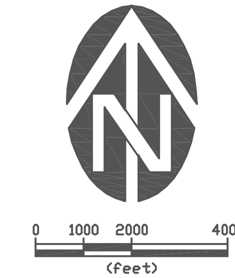
TABLE 12-2 CIP PRIORITIZATION MATRIX

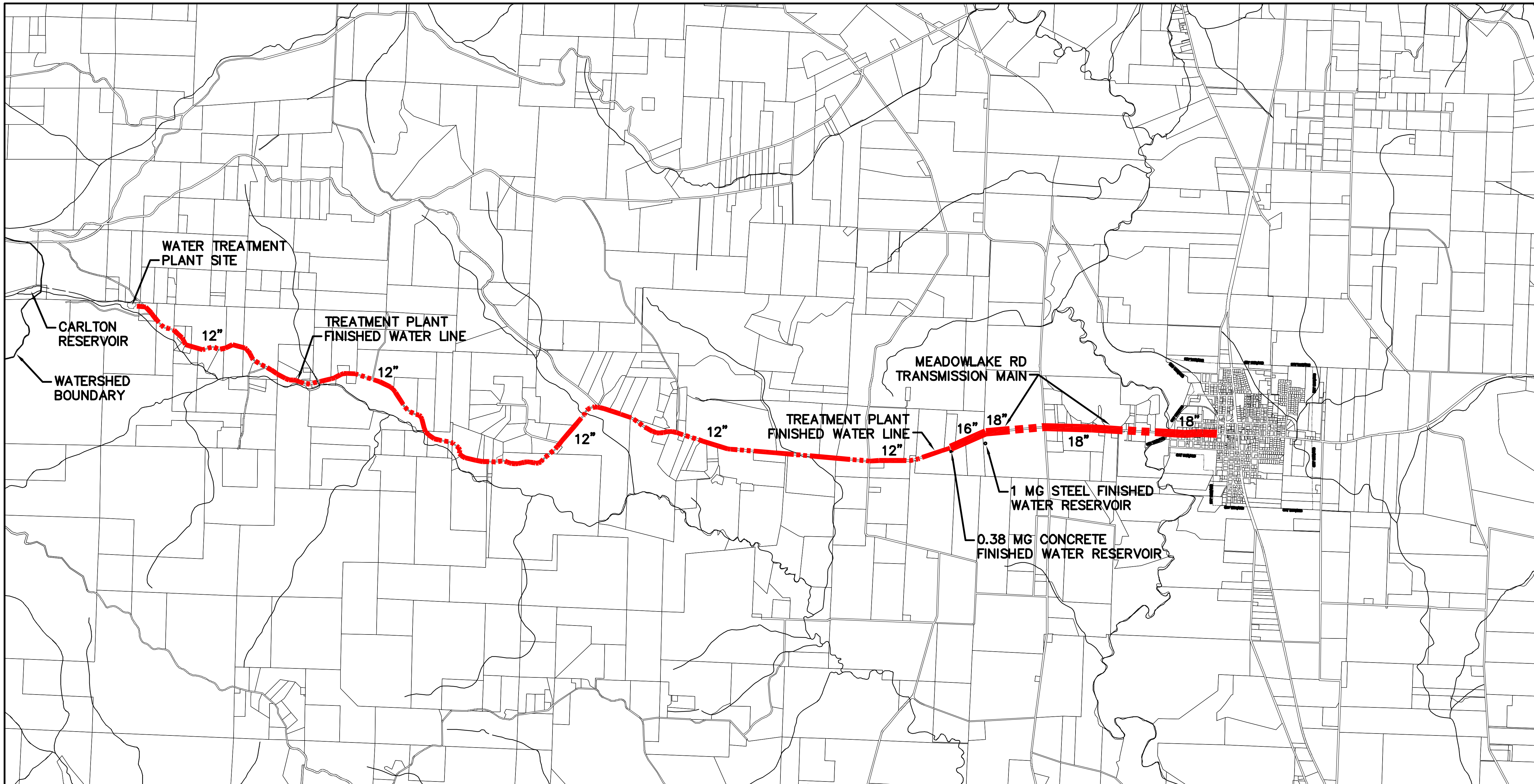
Project	Project Description	Estimated Project Cost	Capital Cost	Consequence of Failure	Probability of Failure	Regulatory Compliance	Improves Fire Flow	Improves Water Quality	Improves Operability	Economic Development	TOTAL POINTS	Priority Group
		Weighing Factor (1-3)	1	3	3	2	2	1	1	1		
Priority 3 Improvements			**Matrix Scoring**: Based on a scale of 1 to 4 with 1 being the 'least favorable' and 4 the 'most favorable'									
D-46	North Scott Street (North of Monroe)	$ 112,000	2	1	1	1	1	1	1	1	**15**	3
D-47	North Scott Street (Monroe to Main)	$ 79,000	2	1	1	1	1	1	1	1	**15**	3
D-48	South 1st Street (Main to Washington)	$ 114,000	2	1	1	1	1	1	1	1	**15**	3
D-49	East Taylor Street (East of Arthur Street)	$ 99,000	2	1	1	1	1	1	1	1	**15**	3
D-50	South Park Street (South of Taylor)	$ 103,000	2	1	1	1	1	1	1	1	**15**	3
D-51	East Main Street (7th to Modaffari)	$ 248,000	1	1	1	1	1	1	1	1	**14**	3
D-52	South 3rd Street (South of Polk Street)	$ 178,000	1	1	1	1	1	1	1	1	**14**	3

Priority 3 Estimated Cost Total
$ 933,000

Project Code Legend:

D = Distribution F = Finished Water Line R = Reservoir/Storage S = Water Source/Supply T = Transmission V = Valve Replacement WT = Water Treatment





City of Carlton, Oregon

WTP FINISHED WATER LINE
MEADOW LAKE RD TRANS MAIN
PRIORITY 1A IMPROVEMENTS

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

VERIFY SCALE
BAR IS ONE-HALF INCH ON ORIGINAL DRAWING
0 .5"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

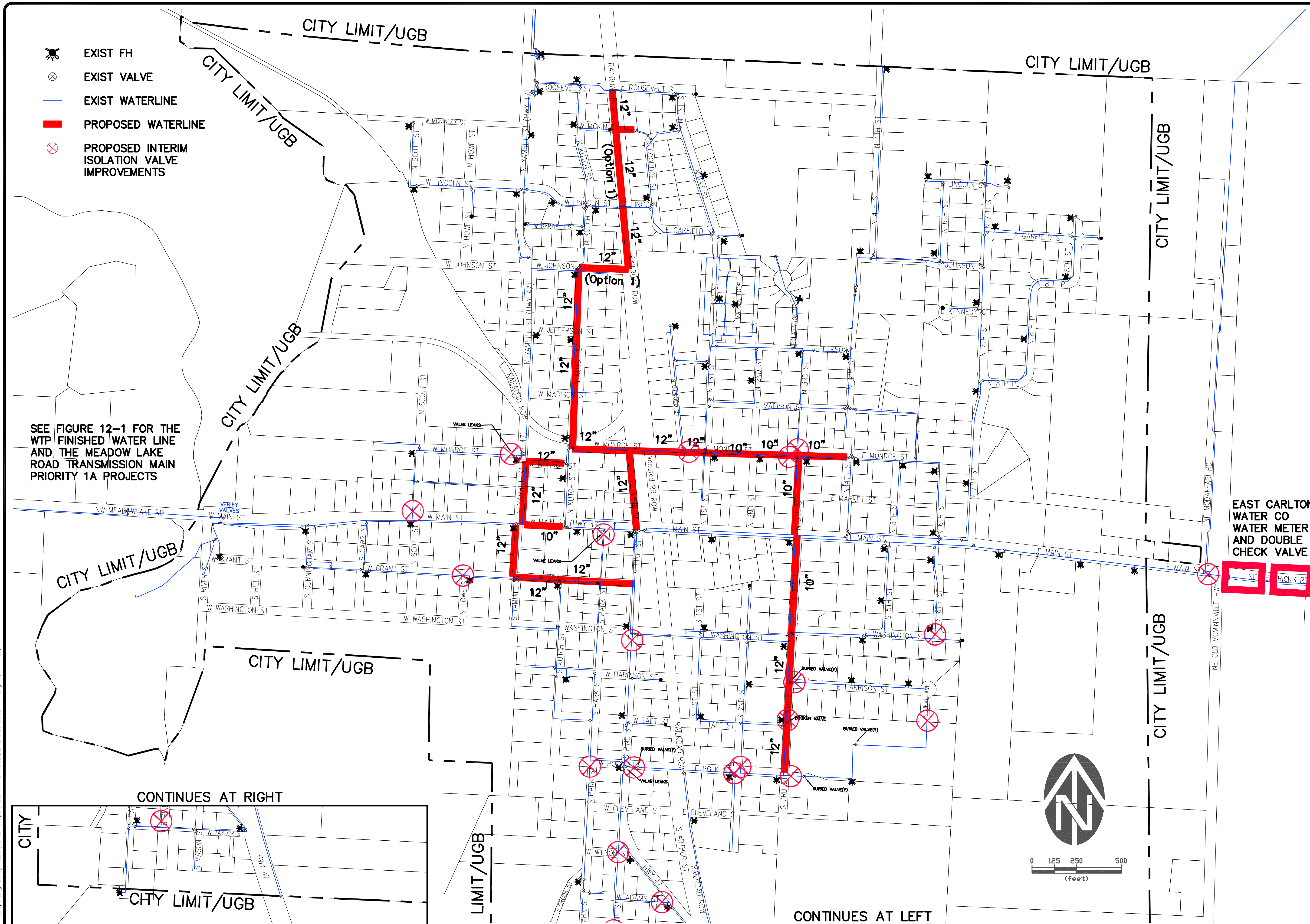
NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

FIGURE
12-1

JOB NUMBER
2674.0000.0

10/14/2014 4:09:09 PM
R:\Maps\City Utility Maps\Carlton\Maps\Water MP Exhibits\12-1 1A Finish WL & Trans Main.dwg, (1117 tab)



City of Carlton, Oregon

DISTRIBUTION MAINS PRIORITY 1A IMPROVEMENTS

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

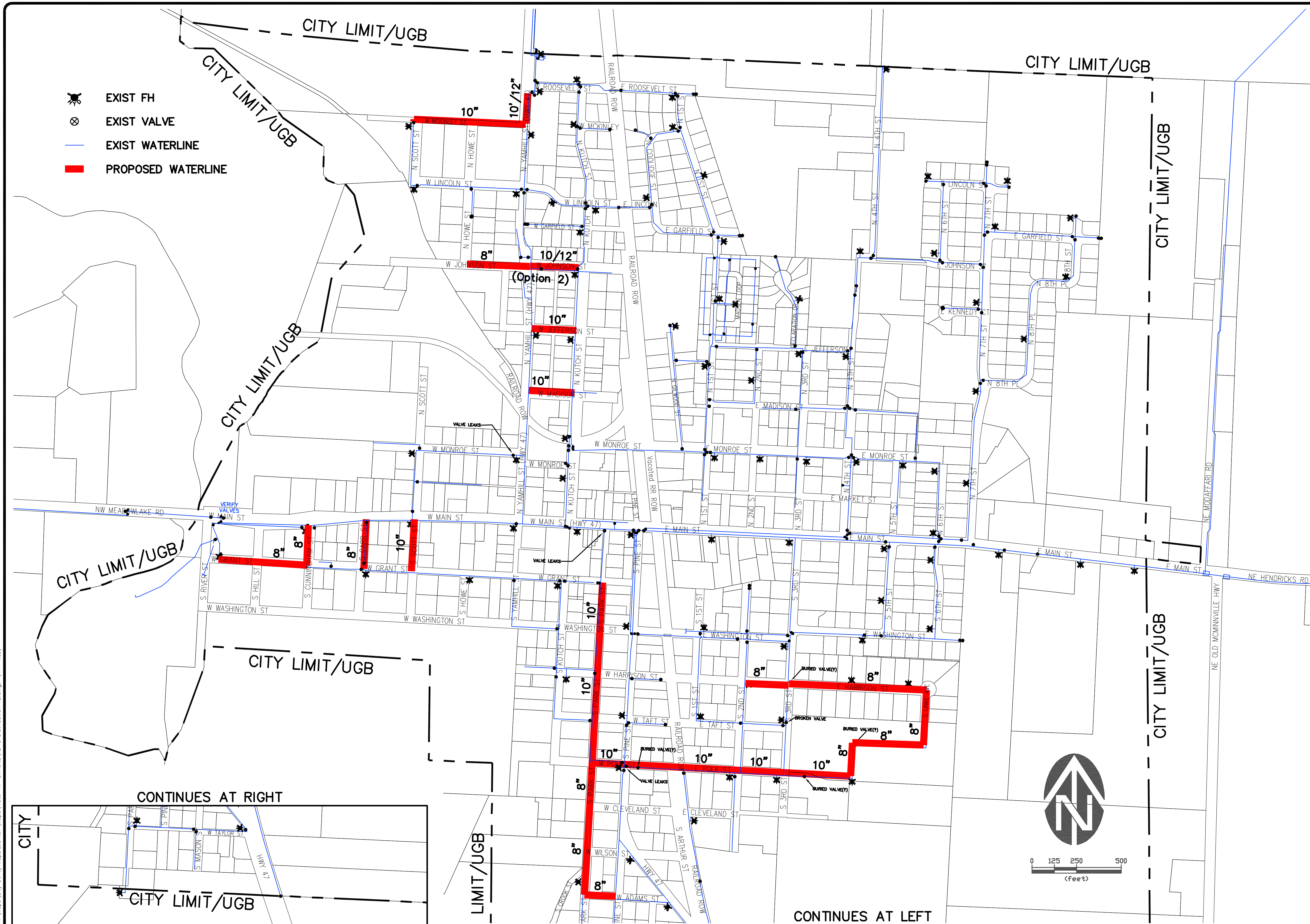
VERIFY SCALE: BAR IS ONE-HALF INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

REVISIONS: NO. | DATE | DESCRIPTION | BY

FIGURE 12-2

JOB NUMBER 2674.0000.0

10/14/2014 4:09:59 PM
R:\Maps\City Utility Maps\Carlton\Maps\Water MP Exhibits\12-2 Distribution 1A.dwg, (1117 tab)



City of Carlton, Oregon

DISTRIBUTION MAINS
PRIORITY 1B IMPROVEMENTS

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

VERIFY SCALE
BAR IS ONE-HALF INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

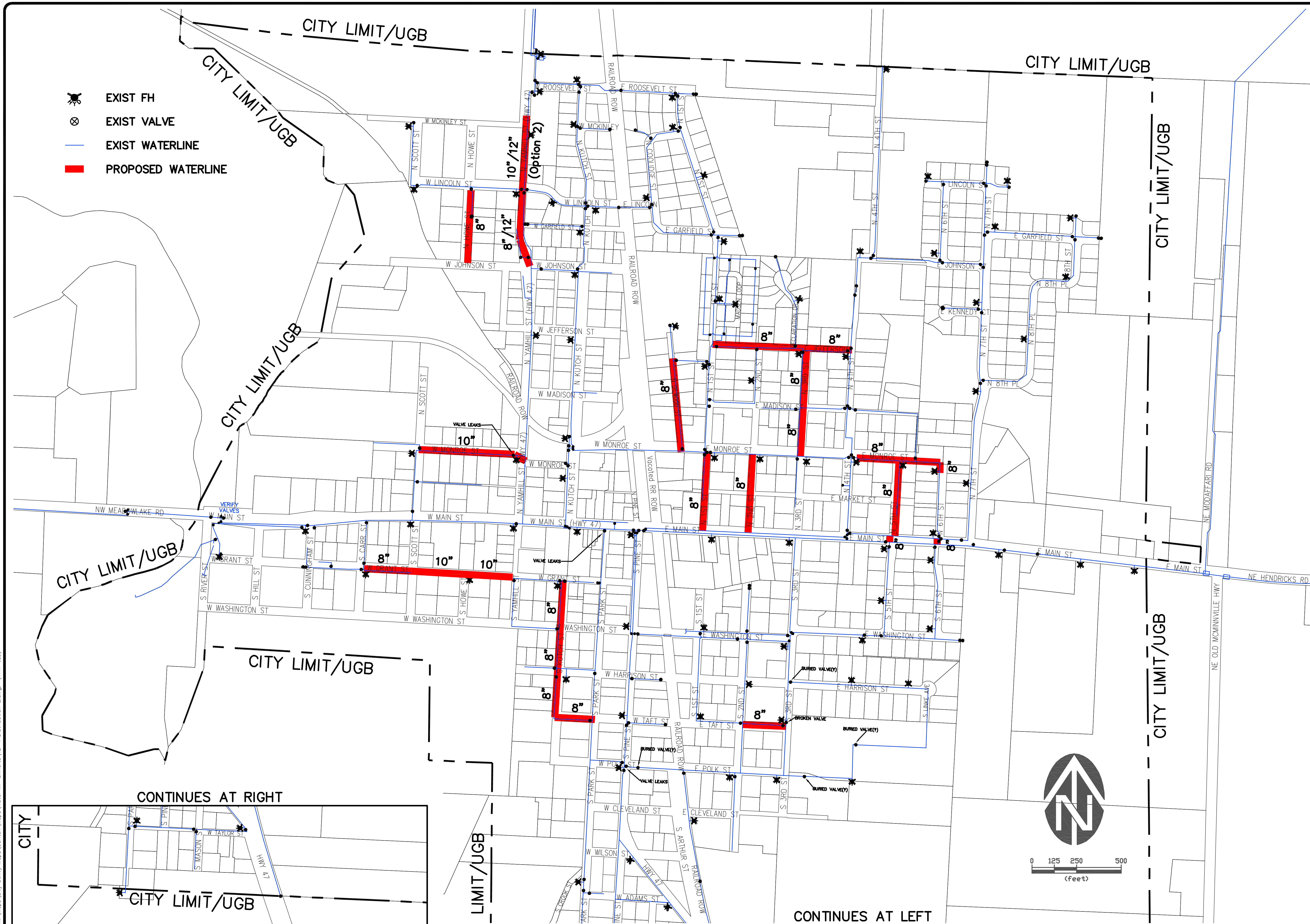
NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

FIGURE 12-3

JOB NUMBER 2674.0000.0

10/14/2014 4:10:44 PM
R:\Maps\City Utility Maps\Carlton\Maps\Water MP Exhibits\12-3 Distribution 1B.dwg, (1117 tab)



City of Carlton, Oregon

DISTRIBUTION MAINS PRIORITY 2 IMPROVEMENTS

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

VERIFY SCALE
BAR IS ONE-HALF INCH ON ORIGINAL DRAWING
0 .5"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

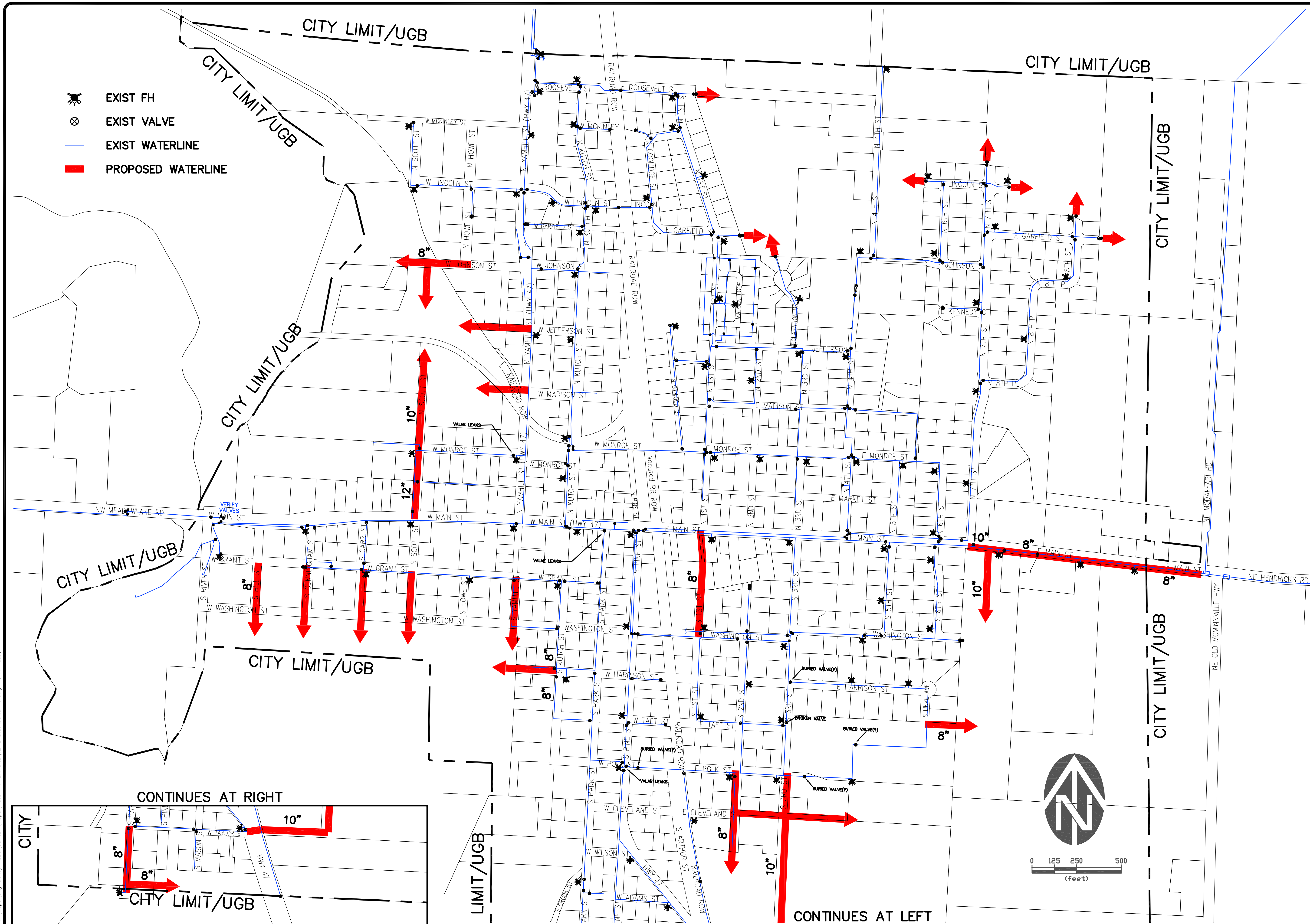
NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

FIGURE 12-4

JOB NUMBER 2674.0000.0

10/14/2014 4:11:27 PM
R:\Maps\City Utility Maps\Carlton\Maps\Water MP Exhibits\12-4 Distribution 2.dwg (1117 tab)



WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

City of Carlton, Oregon

DISTRIBUTION MAINS PRIORITY 3 IMPROVEMENTS

FIGURE 12-5

JOB NUMBER 2674.0000.0

NO.	DATE	DESCRIPTION	BY
1		REVISIONS	

VERIFY SCALE: BAR IS ONE-HALF INCH ON ORIGINAL DRAWING. IF NOT ONE-HALF INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DSN. RCE
DRN. RCE
CKD. RCE
DATE: MAR 13

10/14/2014 4:12:03 PM
R:\Maps\City Utility Maps\Carlton\Maps\Water MP Exhibits\12-5 Distribution 3.dwg, (11x17 tab)

12.2.4 Environmental Impacts

It should be noted that while the improvements recommended in this report are not anticipated to have significant adverse impacts on the environment, each CIP project may need to undergo project-specific environmental review as part of the preliminary and final design process, if required by funding agencies.

12.3 BASIS OF COST ESTIMATES

In order to forecast municipal capital expenditures, cost estimates have been prepared for each improvement alternative. The preparation methodology and intended use of these cost estimates is summarized below. The cost estimates are based on numerous assumptions necessary due to the relative lack of detail available at the master planning stage.

12.3.1 Accuracy of Cost Estimates

The accuracy and precision of cost estimates is a function of the level to which improvement alternatives are developed (i.e., detail and design) and the techniques used in preparing the actual estimate. Estimates are typically divided into three basic categories as follows:

- *Planning Level Estimate*. These are order-of-magnitude estimates made without detailed engineering design data. They are often performed prior to the project or at project startup and typically range from 35 percent over to 25 percent below the final project cost. A relatively large contingency is typically included to reduce the risk of under-estimating. This is particularly important since many times the project financing must be secured before the detailed design can proceed.
- *Budgetary Estimates*. This level of estimate is prepared during the preliminary design phase using process flow sheets, preliminary layouts and equipment details. This type of estimate is typically accurate to +30 and –15 percent of the final project cost.
- *Engineer's Estimate*. This estimate is prepared on the basis of well-defined engineering data, typically when the construction plans and specifications are completed. The estimating process at this level relies on piping and instrument diagrams, electrical diagrams, equipment data sheets, structural drawings, geotechnical data and a complete set of specifications. The engineer's estimate is expected to be accurate within +15 to –5 percent of the pricing secured during the bidding process.

The project costs prepared as part of this study are planning level estimates. Actual project costs will depend on the final project scope, labor and material costs, market conditions, construction schedule, and other variables at the time the project is built. These variables are typically uncertain at the time planning level estimates are performed.

12.3.2 Adjustment of Cost Estimates over Time

A commonly used indicator to evaluate the change of construction costs over time is the Engineering News-Record (ENR) construction cost index. The index is computed from the prices for structural steel, Portland cement, lumber, and common labor, and is based on a value of 100 in the year 1913. The construction costs developed in this analysis are based on the August 2013 ENR 20 City Construction Cost Index of 9545. As the planning period elapses, the costs presented in this study can be updated to the present, by applying the ratio of the current cost index to the index used during the preparation of the estimate.

Although the costs of material, labor and equipment rise over time and affect the cost of the recommended alternatives, since the relative costs of the alternatives compared to each other should remain reasonably constant, the recommendations/prioritizations based on the cost estimates should remain valid.

12.3.3 Engineering and Administrative Costs, Contingencies

The cost of engineering services for major projects typically covers special investigations, pre-design reports, topographic surveying, geotechnical investigations, contract drawings and specifications, construction administration, inspection, project start-up, the preparation of O&M manual narratives, and performance certifications. Depending on the size and type of the project, engineering costs may range from 16 to 25 percent of the contract cost when all of the above services are provided. The lower percentage applies to large projects without complex mechanical systems. The higher percentage applies to smaller, more complex projects that require the integration of a complex design into an existing facility, and/or where full time inspection is required by the funding agencies or desired by the Owner.

The City will have administrative costs associated with any construction project. These include internal planning and budgeting costs, administration of engineering and construction contracts, legal services, and coordination with regulatory and funding agencies. Typical projects as recommended in this study are expected to be 10 percent of the construction contract cost. The total cost for engineering and administration is assumed to be 30 percent of the construction contract cost.

Since the funding sources for the completion of the recommended improvements have not yet been confirmed, the cost estimates outlined below are based on the assumption that each of the projects will be designed and constructed separately with local funds.

12.4 CONSTRUCTION COST ESTIMATES

The planning level estimates for the water system improvements recommended in this study are based on a number of assumptions as follows. The cost estimates reflect projects bid in late winter or early spring for summer construction. The estimates are based on construction costs of similar historical projects and on current estimates solicited from material and equipment vendors. The estimates are expected to have accuracies of +35 percent and –25 percent of the actual project cost. The following sections describe the cost estimating process for the various categories of projects.

12.4.1 Pipeline Improvement Costs

The proposed pipeline improvement projects range in size from 6-inches to 18-inches in diameter. These costs were developed using the following assumptions:

- Pipe material for buried pipelines is CL 52 DI within the City Limits/UGB and C900 PVC outside the City Limits/UGB
- Installation of valves and hydrants are included and shall be installed per the City's PWDS
- Standard cover is 3 feet, and trenching costs exclude rock excavation and trench dewatering
- Reconnection of all services are included for waterline replacement projects
- Asphalt trench repair for the full length of the project for the trench width only
- Highway bores must be added to the unit costs at $600 per linear foot

- Construction contingencies are 10% of estimated construction cost
- Engineering design, survey and construction administration is 16% of construction cost
- Legal, permits and administrative costs are 10% of estimated construction cost

Total project costs per foot of installed pipe appear in **Table 12-3**, along with the percentages listed above for engineering design and administrative costs.

Table 12-3 Estimated Pipeline Improvement Costs

Diameter	Total Cost per Foot
6-inch	$72
8-inch	$96
10-inch	$120
12-inch	$144
16-inch	$192
18-inch	$216
Highway Bores	$500
New Fire Hydrants	$4,000 each
Infill Fire Hydrants	$7,500 each
4-inch Isolation Valve	$9,500
6-inch Isolation Valve	$11,000
8-inch Isolation Valve	$12,500
Connections	case by case basis

Unit costs for hydrant infill projects assume a mainline tee, 6-inch gate valve, a 15-foot hydrant lead, hydrant, thrust blocks at the mainline tee, labor, excavation, backfill & surface restoration.

12.4.2 Source Improvement Costs

Construction costs dredging Carlton Reservoir assume removal of 12 acre-feet of sediment and transporting it up to 5 miles from the reservoir. Project costs have been based on historical construction cost information for similarly sized projects.

A construction contingency of 15%, an engineering design cost of 20% and an administrative, legal and permitting cost of 10% was assumed for these projects.

12.4.3 Water Treatment Improvement Costs

Construction costs for the improvements at the water treatment improvements include site preparation and foundation, building, associated mechanical piping and pumping, as well as electrical and instrumentation modifications.

A construction contingency of 15%, an engineering design cost of 20% and an administrative, legal and permitting cost of 10% was assumed for this project.

12.4.4 Water Storage Improvement Costs

Construction costs for repainting the 1 MG steel reservoir assume painting both the inside and outside of the tank and are based on historical values.

Construction contingencies of 15%, engineering design costs of 20% and administrative, legal and permitting costs of 10% have been assumed for these projects.

12.4.5 Instrumentation and Control Improvement Costs

As discussed in Chapter 11, the City's SCADA and instrumentation and control system is in need of upgrades to address some deficiencies in the existing SCADA system. As noted, the costs for these upgrades will be developed separately by the City's SCADA/Telemetry/Control System consultant of record. In other cases, improvements are needed to bring some of the sources under the SCADA system umbrella. Estimates for the cost of I&C improvements at existing and proposed facilities has been included in the overall cost of the respective projects.

Costs have been based on similarly configured historical projects. A construction contingency of 15%, an engineering design cost of 20% and an administrative, legal and permitting cost of 10% was assumed for these projects.

12.5 FUNDING SOURCES

As a general rule, small communities are not able to finance major water system improvements without some form of government funding such as low interest loans or grants. It is anticipated that the funding for the recommended capital improvement plan outlined in this report will be secured from multiple sources, including system development charges (SDCs), monthly user fees, as well as state and federal grand and loan programs. The following section outlines the major local and State/Federal funding programs that may be available for these projects.

12.5.1 Local Funding Sources

To a large degree, the type and amount of local funding used for the water system improvements will depend on the amount of grant funding obtained and the requirements of any loan funding. Local revenue sources for capital improvements include ad valorem taxes (property taxes), various types of bonds, water user fees, connection fees and SDCs. Local revenue sources for operating costs include ad valorem taxes and water user fees. The following sections discuss local funding sources and financing mechanisms that are most commonly used for the type of capital improvements presented in this study.

12.5.1.1 Existing Debt Service

Based on City records, the City currently has at total of approximately $3,156,843 in outstanding water system debt, based on a loan through the Oregon Economic and Community Development Department (OECDD) [now the Business Oregon-Infrastructure Finance Authority (IFA)]. The City is currently budgeting for annual payments of $143,333 and anticipates retiring the debt in December 2035.

12.5.1.2 User Fees

User fees are monthly charges to all residences, businesses, and other users that are connected to the water system. User fees are established by the City Council and are typically the sole source of revenue to finance water system operation and maintenance. These fees are periodically modified to account for changes in operation and maintenance costs, and the need for new improvements. Although user fees are typically not sufficient to directly finance major capital construction projects up front, they can be used to repay long term financing. A copy of the current rate structure appears in **Table 4-9**.

Residential and commercial monthly user rates are determined by the combination of a fixed base rate, and a variable rate based on the volume of water consumed. The fixed base rate is assigned on the basis of EDUs service by the meter.

As noted under Section 4.9.1, the estimated typical monthly residential water bill would be approximately $63.20 for a single family residence (assuming 100 gallons/capita/day, 2.91 residents/household and a 30 day month).

12.5.1.3 System Development Charge Revenues

A system development charge (SDC) is a fee collected by the City as each piece of property is developed (i.e. SDC fees are collected at issuance of building permits). SDCs are used to finance necessary capital improvements and municipal services required by the development. SDCs can be used to recover the capital costs of infrastructure required as a result of the development, but <u>cannot</u> be used to finance either operation and maintenance, or replacement costs.

SDC fees are set by resolution of the Council. The current SDCs fees are based on meter size with a 5/8 to 1-inch meter as the base meter size. The water SDC for a typical residential unit is currently $6,310.

As established in ORS 223, an SDC can have two principal elements, the reimbursement fee and the improvement fee. The reimbursement fee portion of the SDC is the fee for buying into either existing capital facilities or those that are under construction (i.e. it represents a charge for utilizing excess capacity in an existing facility that was paid for by the City or previous developers). The revenue from this fee is typically used to repay existing improvement loans.

The improvement fee portion of the SDC is the fee designed to cover the costs of capital improvements that must be constructed to provide an increase in capacity to support development and growth. Based on the infrastructure improvements and cost projections presented in this master plan, the existing SDC fee structure is insufficient to meet the planning period goals. This plan accordingly recommends that the City complete a full review of its SDC rate structure and update these fees accordingly.

12.5.1.4 Connection Fees

Many cities charge connection fees to cover the cost of connecting a new development to the municipal water system. There are two types of connection fees. The first is for newly constructed connections and is designed to cover the cost of City inspections at the time of connection to the distribution system. The second type of fee is designed to defray the City’s administrative cost of setting up a new account and is charged against newly constructed connections as well as transfers of an existing service to a new owner.

12.5.1.5 Capital Construction Fund

Capital construction funds or sinking funds, are often established as a budget line item to set aside money for a particular construction purpose. A set amount from each annual budget is deposited in a sinking fund until sufficient reserves are available to complete the project. Such funds can also be developed from user fee revenues of from SDCs. It is recommended that the City begin setting aside reserves to prepare for the Phase 1 & 2 improvements that will be required during the planning period.

12.5.1.6 General Obligation Bonds

The sale of municipal general obligation bonds is one method of funding municipal water improvement projects. General obligation bonds utilize the City's basic taxing authority and are retired with property taxes based on an equitable distribution of the bonded obligation across the City's assessed valuation. General obligation bonds are normally associated with the financing of facilities that benefit an entire community and must be approved by a majority vote of the City's voters.

General obligation bonds are backed by the City's full faith and credit, as the City must pledge to assess property taxes sufficient to pay the annual debt service. This portion of the property tax is outside the State constitutional limits that restrict property taxes to a fixed percentage of the assessed value. The City may use other sources of revenue, including water user fee revenues, to repay the bonds. If it uses other funding sources to repay the bonds, the amount collected as taxes is reduced commensurately.

The general procedure followed when financing water system improvements with general obligation bonds is typically as follows:

- Determination of the capital costs required for the improvement
- An election by the voters to authorize the sale of bonds
- The bonds are offered for sale
- The revenue from the bond sale is used to pay the capital cost of the project(s)

General obligation bonds can be "revenue supported", wherein a portion of the user fee is pledged toward repayment of the bond debt. The advantage of this method is that the need to collect additional property taxes to retire the bonds is reduced or eliminated. Such revenue supported general obligation bonds have most of the advantages of revenue bonds in addition to a lower interest rate and ready marketability.

The primary disadvantage of general obligation debt is that it is often added to the debt ratios of the City, thereby restricting the flexibility of the municipality to issue debt for other purposes.

12.5.1.7 Revenue Bonds

Revenue bonds are similar to general obligation bonds, except they rely on revenue from the sales of the utility (i.e. user fees) to retire the bonded indebtedness. The primary security for the bonds is the City's pledge to charge user fees sufficient to pay all operating costs and debts service. Because the reliability of the source of revenue is relatively more speculative than for general obligation bonds, revenue bonds typically have slightly higher interest rates.

The general shift away from ad valorem property taxes makes revenue bonds a frequently used option for payment of long term debt. Many communities prefer revenue bonding, because it ensures that no additional taxes are levied. In addition, repayment of the debt obligation is limited to system users since repayment is based on user fees.

One advantage with revenue bonds is that they do not count against a City's direct debt. This feature can be a crucial advantage for a municipality near its debt limit. Rating agencies closely evaluate the amount of direct debt when assigning credit ratings. There are normally no legal limitations on the amount of revenue bonds that can be issued; however, excessive issue amounts are generally unattractive to bond buyers because they represent higher investment risks.

Under ORS 288.805-288.945, Cities may elect to issue revenue bonds for revenue producing facilities without a vote of the electorate. Certain notice and posting requirements must be met and a sixty (60) day waiting period is mandatory.

The bond lender typically requires the City to provide two additional securities for revenue bonds that are not required for general obligation bonds. First, the City must set user fees such that the net projected cash flow from user fees plus interest will be at least 125% of the annual debt service (a 1.25 debt coverage ratio). Secondly, the City must establish a bond reserve fund equal to maximum annual debt service or 10% of the bond amount, whichever is less.

12.5.1.8 Improvement Bonds

Improvement (Bancroft) bonds are an intermediate form of financing that are less than full-fledged general obligation or revenue bonds. This form of bonding is typically used for Local Improvement Districts.

Improvement bonds are payable from the proceeds of special benefit assessments, not from general tax revenues or user fees. Such bonds are issued only where certain properties are recipients of water system improvements. For a specific improvement, all property within the designated improvement district is assessed on the same basis, regardless of whether the property is developed or undeveloped. The assessment is designed to divide the cost of the improvements among the benefited property owners. The manner in which it is divided is in proportion to the direct or indirect benefits to each property. The assessment becomes a direct lien against the property, and owners have the option of either paying the assessment in cash, or applying for improvement bonds. If the improvement bond option is taken, the City sells Bancroft Improvement Bonds to finance the construction, and the assessment is paid over 20 years in 40 semiannual installments plus interest.

The assessments against the properties are usually not levied until the actual cost of the project is determined. Since the determination of actual costs cannot normally be determined until the project is completed, funds are not available from assessments for the purpose of paying costs at the time of construction. Therefore, some method of interim financing must be arranged.

The primary disadvantage to this source of revenue is that the development of an assessment district is very cumbersome and expensive when facilities for an entire City are contemplated. Therefore, this method of financing should only be considered for discrete improvements to the collection system where the benefits are localized and easily quantified.

12.5.1.9 Certificates of Participation

Certificates of Participation are a form of bond financing that is distinct from revenue bonds. While it is more complex, and typically has a higher interest rate than revenue bonds, it is a process controlled by the City Council, and it does not have to be referred to the voters. This can result in significant time savings.

12.5.1.10 Ad Valorem Taxes

Ad valorem property taxes were often used in the past as a revenue source for public utility improvements. These taxes were the traditional means of obtaining revenue to support all local governmental functions. Ad valorem taxation is a financing method that applies to all property owners that benefit, or could potentially benefit from a water system improvement, whether the property is developed or not. The construction costs for the improvement project are shared proportionally among all property owners based on the assessed value of each property. Ad valorem taxation, however, is less likely to result in individual users paying their proportionate share of the costs as compared to their benefits.

12.5.2 State and Federal Grant and Loan Programs

Several state and federal grant and loan programs are available to provide financial assistance for municipal water system improvements. The primary sources of funding available for water system financing are Rural Utilities Service (RUS), Special Public Works Fund (SPWF), the Water/Wastewater (W/W) Financing Program, the Community Development Block Grant (CDBG) program, and the Drinking Water State Revolving Fund (DWSRF).

Current limitations on grant funds are $3,000,000 per project (2014 draft) and user rates "at construction completion... must be at or exceed the current percentage (1.25%) of the current Median Household Income (MHI) as defined by the most recent American Community Survey 5 year estimate" for the area.

Some of these funding sources are dependent on the percentage of families classified as low or moderate income. Communities with high portions of low and moderate income families may qualify for a number of grant and low interest loan programs. For Carlton, the current data (based on the 2000 census) is that 50.7% of families are classified as low or moderate income. This calculation was from the U.S. Housing and Urban Development web site from a spreadsheet table calculated for “Non-Entitled Local Government Summaries” for FY 13.

Many communities have performed income surveys and have found that the percentage of families classified as low or moderate is actually higher than revealed by the census data. Should the City suspect that the actual percentage of low and moderate income families is higher than the census data, an income survey may be performed. In Oregon, income surveys are typically performed by the Portland State University Center for Population Research for a minimal cost.

12.5.2.1 Rural Utility Services

Rural Utility Service (RUS) provides federal loans and grants to rural municipalities, counties, special districts, Indian tribes, and not-for-profit organizations to construct, enlarge, or modify water treatment and distribution systems and wastewater collection and treatment systems. Preference is given to projects in low-income communities with populations below 10,000.

Borrowers of RUS loans must be able to demonstrate the following:

- Monthly user rates must be at or above the state-wide average.
- They have the legal authority to borrow and repay loans, to pledge security for loans, and to operate and maintain the facilities and services.
- They are financially sound and able to manage the facility effectively.

- They have a financially sound facility based on taxes, assessments, revenues, fees, or other satisfactory sources of income to pay for all facility costs including O&M and to retire indebtedness and maintain a reserve.

The maximum RUS loan term is 40 years, but the finance term may not exceed statutory limitations on the agency borrowing the money or the expected useful life of the improvements. The reserve can typically be funded at 10 percent per year over a ten-year period. Interest rates for RUS loans vary based on median household income, but tend to be lower than those obtained in the open market.

12.5.2.2 Business Oregon-Infrastructure Finance Authority (IFA)

The Business Oregon-Infrastructure Finance Authority (IFA) manages a number of grant and low interest loan programs as describe in the following sections.

12.5.2.2.1 Special Public Works Fund

The Business Oregon-Infrastructure Finance Authority(IFA) administers the Special Public Works Fund (SPWF) program. The SPWF is a lottery-funded loan and grant program that provides funding to municipalities, counties, special districts, and public ports for infrastructure improvements to support industrial/manufacturing and eligible commercial economic development. Eligible commercial economic development is defined as commercial activity that is marketed nationally, or internationally, and attracts business from outside Oregon. Funded projects are usually linked to a specific private sector development and the resulting direct job creation (i.e., firm business commitment), of which 30% of the created jobs must be "family wage" jobs. The program also funds projects that build infrastructure capacity to support industrial/manufacturing development where recent interest by eligible business(s) can be documented.

The SPWF is primarily a loan program, although grant funds are available based on economic need of the community. Although the maximum loan term is 25 years, loans are generally made for 20-year terms. The maximum loan amount for projects funded with direct SPWF money is $1 million, while the maximum for projects financed with bond funds is $10 million.

12.5.2.2.2 Bond Bank Program

The Bond Bank program, administered by IFA, attempts to lower the cost of issuing debt by pooling small revenue bond issues from many communities into one large revenue bond issue. It uses lottery proceeds to write down financing costs, and to improve the debt/equity ratio on projects. The interest rate for repayment of funds is typically around 6 percent, with up to a 25 year term.

12.5.2.2.3 Water/Wastewater Financing Program

IFA also administers the W/W Financing Program, which gives priority to projects that provide system-wide benefits and helps communities meet the Clean Water Act or the Safe Drinking Water Act standards. It is intended to assist local governments that have been hard hit with state and federal mandates for public drinking water systems and wastewater systems. In order to be eligible for this program, the system must be out of compliance with federal or state rules, regulations or permits, as evidenced by issuance of Notice of Non-Compliance by the appropriate regulatory agency. The funded project must be needed to meet state or federal regulations. Priority is given to communities under economic distress.

Similar to the SPWF, the W/W Financing Program is primarily a loan program, although grant funds are available in certain cases, based on economic need of the community. Although the maximum loan term is 25 years, loans are generally made for 20-year terms. The maximum loan amount for projects funded with direct W/W money is $500,000, while the maximum for projects financed with bond funds is $10 million.

12.5.2.2.4 Economic and Community Development Block Grant

The IFA administers the CDBG, but the funds are from the U.S. Department of Housing and Urban Development (HUD), so all federal grant management rules apply to the program. The federal eligibility standards are strict. There are two subcategories of Public Works projects eligible for funding, "Public Water and Wastewater," and "Public Works for New Housing." Only the former is considered in this discussion.

Grants are available for critically needed construction, improvement, or expansion of publicly owned water and wastewater systems for the benefit of current residents. Generally, projects must be necessary to resolve regulatory compliance problems identified by state and/or federal agencies and the project must serve a community that is comprised of more than 51% of low and moderate income persons.

It should be noted that CDBG funds cap contingency costs at 10%. Cost estimates in this report provide a 15% contingency which would need to be adjusted if CDBG grants are used. As a general rule all IFA funding programs limit construction contingency to 10% and engineering to 20%.

CDBG Public Works projects must qualify as benefitting area-wide Low and Moderate Income (LMI) “area-wide is the service area boundaries” – the City would be required to income survey all users outside the city limits to determine the LMI % of the users of the system (the 50.7% LMI for Carlton only reflects users inside the city limits) and public works projects must also benefit at least 51% current residential population.

The program separates projects into three parts. Grants are available for:

- *Preliminary Engineering and Planning Projects*. Generally, these grants fund preparation or update of Water System Master Plans and Wastewater Facility Plans, as required by the Oregon Department of Environmental Quality or Oregon Health Division. In addition, funds for grant administration and preparation of a final design funding application can be included in the project budget. All plans produced with grant funds must be approved by the appropriate regulatory agency. Grants of up to $10,000 can also be made for problem identification studies to delineate problems and corrective measures, as required by a regulatory agency.
- *Final Design and Engineering Projects*. Final design and engineering, bid specifications, environmental review, financial feasibility, rate analysis, grant administration, and preparing a construction funding application are all eligible project activities. The final design, plans and specifications must be approved by the appropriate regulatory agency before a grant will be awarded.
- *Construction Projects*. These grants fund construction and related activities, grant administration, and land/permanent easement acquisition. IFA has established an evaluation system that gives priority to projects that provide system-wide benefits. The overall maximum grant amount per water or wastewater project is $1,000,000 (including all planning, final engineering, and construction). The project cannot be divided locally into phases with the expectation of receiving more than one

$1,000,000 grant. In order to qualify for grant funding under this program, the water user rates must be at or above statewide averages.

12.5.2.3 Safe Drinking Water Loan Fund & Drinking Water Protection Loan Fund

The Safe Drinking Water Loan Fund is administered by IFA with assistance from ODWS and provides loans to cities, counties, special districts, and Indian tribes to construct, expand, or rehabilitate water treatment, distribution, and storage facilities in order to comply with the federal Safe Drinking Water Act.

Interest rates on loans are about 80% of the general obligation bond rate; however, there are additional financing costs and annual service fees that increase the effective rate. The maximum loan amount per project is $6,000,000. The maximum loan term is 20 years except for disadvantaged communities that may qualify for loan terms up to 30 years provided the loan term does not exceed the useful life of the facility being constructed.

12.5.2.4 Water Development Loan Fund

The Water Development Loan Fund is administered by the Oregon Water Resources Department. This program provides loans to municipal water suppliers with a population under 30,000. These loans are available with up to 30-year terms.

12.5.3 Funding Recommendations

As available grant funding on public works projects has decreased in the last several years, it will be incumbent upon the City to aggressively pursue funding to finance the cost of the recommended improvements that are in excess of the pro-rata costs contributed by the State.

Based on the infrastructure improvements and cost projections presented in this master plan, the existing SDC fee structure is insufficient to meet the planning period goals. This plan accordingly recommends that the City complete a full review of its SDC rate structure and update these fees accordingly. All funding options will likely include an increase of the user rate and SDCs.

Another important element of the funding process is to schedule a "one stop meeting" with Business Oregon-Infrastructure Finance Authority (IFA). The preparation of applicable grant applications should begin as soon as possible. Depending on the low and moderate income calculations at the time of application, the City may qualify for a number of grant programs based on the percentage of low and moderate incomes in the community.

As previously described, in order to demonstrate that they qualify for certain programs, many communities have performed local income surveys and have determined that a greater percentage of households fall under the low or moderate income category than determined by the census data. If the City believes the actual percentage of low and moderate income families is higher than revealed by the census data, a local income survey may be performed.

Based on the 2000 census data, 50.7% of the households in the City fall into the low or moderate income category.

If the City decides to perform a local income survey to obtain a more accurate measurement of the percentage of low and moderate income families, the cost for such a survey is likely to be in the $8,000 to $10,000 range and is not eligible for reimbursement under a grant if secured. Municipalities interested in completing a survey are required to contact the IFA regional coordinator prior to beginning the survey.

The information in **Table 12-4** was prepared to assist the City in determining whether or not an income survey would be beneficial. This table shows the communities that have performed local income surveys after the 2000 census and how the results of the local survey differed from the 2000 census data. For comparison purposes, the percent of low/moderate income from the 1990 census or a local survey performed before 2000 is also included. With the exception of Cottage Grove, all of the communities saw an increase in the percentage of low and moderate income families when a local survey was performed. Some communities saw dramatic increases. This will obviously be impacted by the state of the economy as we move forward from the 2010 census data.

Table 12-4 Effects of Local Income Surveys for Communities in Oregon

Community	Low/Moderate Income as a Percentage of Population (1990 Census or Local Data)	Low/Moderate Income as a Percentage of Population (2000 Census)	Low/Moderate Income as a Percentage of Population (post 2000 Local Survey)
Cascade Locks	47.9%	37.5%	58.5%
Cottage Grove	59.5%	50.6%	48.0%
Brownsville	46.9%	46.0%	58.0%
Mill City	56.0%	50.5%	53.5%
Vale	61.9%	49.8%	57.4%
Aumsville	56.1%	44.6%	74.3%
Jefferson	62.0%	44.1%	57.3%
Mt. Angel	55.8%	43.2%	66.3%
Independence	55.9%	48.0%	79.5%
Monmouth	52.1%	48.6%	67.3%
Yamhill	57.3%	39.9%	64.8%

Data compiled from 2003 Oregon Community Development Block Grant Guidelines – Appendix A and 2005 Oregon Community Development Block Grant Guidelines – Appendix A

12.6 RECOMMENDED IMPLEMENTATION PLAN

It is recommended that the City begin design work on the Priority 1A and 1B improvements as soon as feasible after final approval of the Master Plan, based on funding availability. Clearly, the Priority 1 improvement projects are substantial. The City should be diligently preparing for the financial requirements of these future projects.

12.6.1 Recommended Implementation Schedule

Given the magnitude of the recommended Priority 1improvements, and the number of steps that must precede construction, the development of a definitive recommended implementation schedule is not possible, because the tasks associated with the Priority 1 improvements are complex and interrelated and are heavily contingent on a acquiring a significant funding package that will provide the cash flow for these projects. However, since many of these projects must be completed in the near future to maintain the reliability and redundancy of the water system, we recommend that that the City proceed with design of selected projects concurrently with investigations for funding packages, and proceed with construction for those specific projects for which local funding can be obtained.

12.6.2 Funding Scenarios (Preliminary Rate Analysis)

A water rate study is being performed concurrent with this Water System Master Plan. Therefore rate analysis information is not included as part of the Water System Master Plan. Those interested in the water rate analysis are encouraged to review the separate water rate study.